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Beyond a conceptual framework : an applied method to assess the potential impact of multi-sectoral approaches on the reduction of child stunting in Yemen (2013-2014)

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Beyond a conceptual framework:
*An applied method to assess the potential impact
of multi-sectoral approaches on the reduction of
child stunting in Yemen (2013-2014)*

A dissertation presented

By

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To

The Department for Health

For the Degree

Doctor of Health Research

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Bath, United Kingdom

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Notation:

Most of the work informing this research was conducted during 2013, 2014 and beginning 2015. The criteria for the selection of Yemen as the country case study included: 1) Availability of data to conduct the analysis in order to identify the suggested mix of public interventions; 2) Opportunity to engage with decision-makers at the highest level to assess how the findings from the analysis were used to inform decisions on the selected mix of public interventions and 3) Political commitment to apply a multi-sectoral approach to reduce the prevalence of child stunting.

Yemen was chosen as the country case study because the Minister of Planning and International Cooperation made an official request for technical assistance to support their planning and financing cycle for nutrition. This request was made in September 2013 and the research author led a multi-disciplinary team to assist the Government of Yemen during 2014 and in the beginning of 2015 prior to the escalation of the conflict.

Key aspects of the method used in 2014 have been applied to inform the current multi-sectoral emergency nutrition response.

Beyond a conceptual framework:

An applied method to assess the potential impact of multi-sectoral approaches on the reduction of child stunting in Yemen (2013-2014)

Abstract:

Background

This research aims to explore the recommendations of the 2013 Lancet Series on maternal and child nutrition in the case study of Yemen (2013-2014), by answering the question “What mix of public interventions works best in a given context to reduce child stunting prevalence?” Yemen was selected due to its Government commitment to use a multi-sectoral approach in its planning and financing cycle for nutrition.

Method

The research applied a mixed method, starting with a literature review and a cross-country secondary-data analysis to produce evidence for composing a research framework for Yemen. Subsequently, a descriptive analysis, two types of regressions (Probit and Poisson) and an adapted ‘Delphi method’ for discussion with decision-makers from various sectors were carried out.

Results

Based on the descriptive analysis, Yemen progressed in: maternal and child health care, drinking water supply and sanitation, girls’ education, delayed marriage and pregnancy. However, infant and young child feeding practices remained inadequate. Significant determinants of child stunting identified by the regressions included characteristics of: child (age, gender and diet diversity), mother (undernutrition, birth-spacing and head of family) and household (access to water and sanitation). Children of households that engaged in agriculture, livestock and fishing were the most likely to access diet diversity and animal-protein sources. Other significant determinants of child diet included maternal education, per capita expenditure, income-related shocks and ownership of a cooking stove and fridge.

Results from the adapted ‘Delphi-method’ discussion showed that decision-makers were ready to use multi-sectoral approaches to converge their existing interventions in the most vulnerable geographical areas. However, they were less keen to retarget beneficiaries based on age, gender or livelihoods.

Conclusions

The research demonstrates how the applied mixed method can provide a comprehensive way to examine child stunting as a multi-sectoral issue, rather than just considering it as a health problem.

Author's research career:

Although I have not pursued an academic research career, 'researching' has always been an integral part of my professional journey.

Since 2011, I have worked for the Secretariat of a multi-stakeholder global initiative called Scaling Up Nutrition (SUN) Movement. The SUN Movement is represented by fifty-nine national Governments who have signed up to reduce the high prevalence of child malnutrition in their own countries. Within the Secretariat I am the Senior Nutrition Analyst and Strategy Advisor. My role is to directly support Government representatives in advancing their national agenda for improving nutrition outcomes. In practice, my role entails the analysis of multi-sectoral framing approaches and their implications in terms of planning, financing and implementation. This in turn translates into a continuous dialogue with national stakeholders to support them in their decision-making processes.

In previous jobs I applied 'research' methods when studying the different stages of policy making and implementation in the field of nutrition. In particular, I worked on the policy implementation aspects for improving access to services by nutritionally vulnerable population groups. My work in Ethiopia on the linkages between two large-scale national programmes (one about nutrition and one about productive safety nets) made me realize how little documentation was available on how to help decision-makers from different sectors to move beyond the conceptual framework. Specifically, data were not used in ways that encouraged decision-makers to look further than their individual efforts in order to assess their collective impact on the nutrition status of their population.

As a University student I spent nine months in Ethiopia looking at participatory community-based methods. I went on to do my dissertation on the role of formal and informal education in the Region of Harar. I have a M.A. in Human Sciences from the University La Sapienza in Rome and a M.Sc. in Development Management, which I completed at the Open University UK while working.

Acknowledgment and dedications:

This thesis is the most tangible outcome of a learning process that has extended over the past six years. I am profoundly indebted to all the people who have made these years a constructive journey. While it is hard to work and study at the same time, it is a privilege to be in a learning environment that helps to keep assumptions in perspective. This work was possible thanks to the constant support and supervision of Dr. Alan Buckingham, whose feedback and questions are a lifetime gift for my personal and professional growth. I am also grateful to Professor Luigi Maria Solivetti, who has accompanied me since my first dissertation back in 1998. Thanks to him, I have fully appreciated the significance of data and the ethics of their use. I also greatly benefitted from the advice of Marie Ryan, who was kind enough to look at early drafts and provide useful suggestions in terms of language and writing style. Professor Jessica Fanzo, Sarah Curran, Dr. Roseline Remans, Dr. Valentina Mara, Joel Sanchez Briseño and Professor Glenn Denning formed a fantastic research group back in 2013 when we started to systematize the literature and the available data on the multiple causes of child stunting. I am also incredibly grateful to Elsa Valli, who has contributed significantly to the modelling part of the quantitative analysis for the Yemen case study. I would like to also acknowledge Dr. Simone Boyce, Dr Helen Connolly and Paul Rees-Thomas, who have been instrumental in the Yemen case study. The Yemen team was a great source of inspiration and knowledge, in particular Dr. Alam Khattak, Dr. Iqbal Kabir and Francesca Eldermann. My deepest thoughts go to the Yemeni colleagues who, despite the war, have never reduced their struggles to build a better future for their children.

Since 2011 I have benefitted greatly from working in a highly dynamic and innovative environment. I would like to acknowledge the charismatic leadership of Dr. David Nabarro, who was the Coordinator of the SUN Movement from 2010 to 2014 and has now become the implementation engine of the Sustainable Development Goals. His endless efforts to connect a huge range of diverse leaders within a space of common understanding has allowed 'nutrition' to be recognized as a core development issue of universal significance.

Finally, and most importantly, I owe this thesis and much more, to my husband and to my family, who supported me and stood by me when I needed it the most. Thank you to my loving Simon, Mamma Ruth, Papà Pier Giorgio, and Sabina. Thank you for always being there for me.

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Acronyms

ANC	Ante Natal Care	RCT	Randomized Control Trial
BFHI	Baby Friendly Hospital Initiative	R&D	Research & Development
BMI	Body Mass Index	SD	Standard Deviation
CBR	Crude Birth Rate	SGA	Small for Gestational Age
CFSS	Comprehensive Food Security Survey	SMART	Standardized Monitoring and Assessment for Relief and Transition
CI	Confidence Interval	SUN	Scaling Up Nutrition
CSO	Central Statistical Office	SAM	Severe Acute Malnutrition
DHS	Demographic Health Survey	TFR	Total Fertility Rate
FAO	Food and Agriculture Organization	UNICEF	United Nation Children Fund
EBF	Exclusive Breastfeeding	USAID	United States Agency for International Development
GDP	Gross Domestic Product	WASH	Water, Sanitation and Hygiene
GFR	General Fertility Rate	WFP	World Food Program
GNI	Gross National Income	WHO	World Health Organization
IFA	Iron Folic Acid	YDMCHS	Yemen Demographic Maternal Child Health Survey
IYCF	Infant and Young Child Feeding	YFHS	Yemen Family Health Survey
KAP	Knowledge Attitude Practice	YMICS	Yemen Multiple Indicators Cluster Survey
LBW	Low Birth Weight	YNDHS	Yemen National Demographic Health Survey
LiST	Lives Saved Tool		
MAD	Minimum Adequate Diet		
MAM	Moderate Acute Malnutrition		
MDD	Minimum Diet Diversity		
MMN	Multiple Micronutrient		
MUAC	Mid Upper Arm Circumference		
ORS	Oral Rehydration Solution/Salt		
ORT	Oral Rehydration Therapy		

Chapter 1: Introduction

Under-nutrition is the single largest contributor to child mortality worldwide underlying 45% or 3.1 million child deaths a year (Black R. et al. 2013). Stunted linear growth of children under five years of age has become the main indicator of under-nutrition because it is highly prevalent in nearly all the low and middle income countries and has important consequences for the child health and development.

The immediate determinants of foetal and child nutrition are adequate food and nutrient intake, feeding, caregiving and parenting practices and low burden of infectious diseases (UNICEF 1990). Bhutta et al. (2013) estimate that, by scaling up ten proven interventions that address immediate determinants to 90% coverage, the global prevalence of child stunting would be reduced only by 20%. These interventions are largely within the health sector and include promotion of maternal, infant and young child feeding practices, supplementation of micronutrients for women and children and treatment of moderate and severe acute malnutrition among children under the age of five.

Evidence from countries that have significantly reduced the prevalence of child stunting demonstrates the associations with changes in underlying determinants of a socio-economic, demographic and environmental nature (Haddad et al. 2014, 2015 and 2016). What stands out is that the policy choices in each case addressed the most significant determinants of under-nutrition and required concerted efforts by a wide range of actors (*ibidem*). Because of the complex nature of under-nutrition, many studies have argued about the necessity to move beyond the health sector in order to understand the contribution from other sectors and disciplines (Pinstrup-Anderson P. 2009 and 2013, World Bank 2006, Heaver 2005, Herforth A. et al. 2012, Spratt 2013).

Since the first release of the Lancet series in 2008 on maternal and child under-nutrition, national and international policy discourses have consistently called for health, agriculture and food systems, education, social protection and water and sanitation to take responsibility for improved nutrition (SUN Movement 2012, World Bank 2006 and 2013, Second International Conference for Nutrition 2014, Haddad et al. 2014, 2015 and 2016). The third paper in the 2013 Lancet Series specifically examined nutrition-sensitive approaches in key sectors and their potential to improve nutrition (Ruel et al. 2013). A fourth paper discussed the features of an enabling environment for nutrition governance (Gillespie et al. 2013).

While the theoretical justification of multi-sectoral approaches is now widely accepted, translating this idea into practice has proven difficult to achieve. There remains a significant methodological gap about 'how' key sectors can practically and effectively maximize their contribution towards the common goal of improving the nutritional status of people, in particular children and women. National nutrition strategies involving multiple sectors have been criticized for the lack of clarity and specificity on the role and responsibility of each sector

(World Bank 2013). Child stunting is perceived as too far down the causal chain to be adopted as an objective by sectors beyond health. While child stunting is recognized as an ultimate impact indicator, the agreement on intermediary indicators at sectoral level could help the involved ministries to measure their own progress and results. Building a common understanding on the determinants of child stunting in a specific context can inform the engagement of key sectors at planning stage and also ensure that each of them takes full responsibility for their policy and programmatic decisions. Institutional levers can be best used if results-based incentives are aligned within multi-sectoral approaches that clearly identify the matrices of roles and accountabilities by the involved ministries (*ibidem*).

This research specifically aims to address this gap by applying a method to help decision-makers from key sectors in the consultation about what mix of public interventions works best to reduce child stunting. The quantitative analysis is expected to support the identification of significant determinants of child stunting in a specific context. The findings are then discussed with the decision-makers to inform their own national policy and programmatic choices. Given the breadth of sectors involved in nutrition, deciding how best to reduce the prevalence of child stunting can be a controversial process. For example, decision-makers from different sectors and organizations see different priorities for action, depending often on their interests in expanding one type of program rather than another. Findings from the quantitative analysis are meant to inform prioritization based on actions that address significant determinants, demonstrating plausible trade-offs within current programs to get better nutrition outcomes for existing investments.

Chapter 2 identifies key determinants that can be plausibly linked to programmes and policies based on the literature review of the effect estimates from evidence-based interventions. Cross-country regression analysis based on secondary data from global datasets are used to describe the determinants that are most significantly associated with child stunting and the contribution of public interventions in health, agriculture, water, sanitation and hygiene (WASH) and social protection. The final section explains the main challenges of multi-sectoral approaches based on the literature review.

Chapter 3 presents a mixed research method, which is tailored to the country case study of Yemen. This country was chosen because of the commitment by the Government to apply a multi-sectoral approach to reduce the prevalence of child stunting as part of their national planning and financing cycle. The Chapter is organized around three research objectives: 1) To identify the mix of public interventions; 2) To assess the relevance of the mix of public interventions and; 3) To discuss the findings with decision-makers. The research used a descriptive analysis for the first research objective, a quantitative analysis for the second research objective and a structured face-to-face consultation process for the third research objective.

Chapter 4 describes the analysis. For the first research objective, the author used data from three population-based surveys conducted in the time frame 2011-2013 in order to describe

the prevalence and trends of child stunting, the immediate and underlying determinants and the key public interventions. For the second research objective, the author accessed the data from one population based survey, which were of sufficient quality to perform the regressions. The first analysis was a Probit regression performed on child stunting in the age group 6-23 months as the primary dependent variable. The model included 31 variables. The second analysis was a Poisson regression performed on child diet in the age group 6-23 months based on a recall time of 24 hours. The model included 38 variables. For the third objective, the research used a face-to-face consultation with 26 decision-makers, who represented Ministries and development partners. The approach used a variation of the Delphi method whereby participants were asked to provide feedback in an open discussion. Participants were involved in focus-group discussions within each sector interfaced with plenary sessions around key issues of convergence and divergence.

Chapter 5 presents the key results. The chapter begins with a description of the nutrition situation in Yemen, highlighting the types of malnutrition with a focus on the magnitude, distribution and changes since 2000. It identifies the immediate and underlying determinants linked to child stunting using both descriptive statistics and statistical analysis. Potential actions are then discussed with decision-makers with respect to policy and programmatic choices, institutional arrangements and financing opportunities. The chapter describes how decision-makers used the data to inform their choices, and what type of trade-offs were applied to decide on which actions to include and which to exclude.

Chapter 6 critically reflects on the usefulness of the mixed method. The descriptive and quantitative analysis provided decision-makers with the required information to systematically assess what mix of public interventions were needed to address key determinants of child stunting. However, the research also acknowledges that final decisions were highly influenced by the existing relationships and arrangements between actors as noted in several studies on the political economy of nutrition and multi-sectoral approaches (Robinson et al. 2000, WHO 2009, Mejia Acosta et al. 2012, Mejia Acosta et al. 2014, Mokoro 2015). The method is useful to help partners identify who is needed and why and, in doing so, highlight gaps. This is especially relevant at a time when Governments are expected to demonstrate leadership by ensuring a coordinated and coherent response by all involved actors. While the study is limited to the national level, the same method could be replicated at sub-national level in countries where programmatic and investment decisions are highly decentralized.

Chapter 2: Global literature review and cross-country secondary data analysis

2.1 Searching the literature and the secondary data

The literature survey started with the 2008 and 2013 *Lancet Series on Maternal and Child Nutrition* as the two key documents informing the current national and international discourses on nutrition. The 2013 *Lancet Series* in particular was used to pursue references and leads in the literature by review of the bibliography. The initial literature survey was aimed at building a library of updated publications relevant to nutrition. These publications were grouped according to nutrition-relevant sectors including: 1) public health, 2) agriculture and food systems, 3) water supply, hygiene and sanitation (WASH), 4) education and 5) social protection. The literature on gender issues was treated as a separate cross-cutting topic. This preliminary phase set the scene both to understand of the current state of the knowledge and to identify key gaps needing further research.

Web-sites specializing in nutrition were the most relevant sources of information for the initial literature survey. The WHO e-Library of Evidence for Nutrition Actions (eLENA) is an online library of evidence-informed guidance for nutrition interventions. It is a single point of reference for the most updated nutrition guidelines, recommendations and related information including supporting materials such as scientific evidence, background materials and commentaries from invited experts (www.who.int/elena/en/).

The UN REACH (www.reachpartnership.org/) and the Scaling Up Nutrition Movement (www.scalingupnutrition.org) were important sources of information on the country-level experiences and practices on the multi-sectoral and multi-stakeholder governance for improved nutrition

The Emergency Nutrition Network platform (www.enonline.net) was used to access publications and grey literature on specific interventions such as management of acute malnutrition as well as interventions in sectors including social protection, agriculture, public health, water supply, sanitation and hygiene (WASH). The ENN is a UK based charity set up to improve practice and strengthen the institutional memory of agencies involved in the food and nutrition sectors, by endorsing evidence based nutrition programming.

Updated papers and articles on policy and programmatic issues were found in the SecureNutrition Knowledge Platform (www.securenutritionplatform.org), the Transform Nutrition Research Programme Consortium (www.transformnutrition.org), the Leveraging Agriculture for Nutrition in South Asia initiative (www.lansasouthasia.org) and the Institute of Development Studies website (www.ids.org). These are all virtual platforms established and managed by research institutes to disseminate their results and provide evidence-based solutions.

For the identification of the articles, different levels of search sophistication were applied. First, search terms included 'nutrition' in combination with relevant sectors such as 'agriculture and food systems' and/or 'social protection' and/or 'public health' and/or 'education' and/or 'gender'. Second, combination of key words were applied using nutrition-relevant outcome areas potentially affected by specific sectors. For example, 'maternal diet + diet diversity + food systems' or 'diarrhoea (Commonwealth English) or diarrhea (American English) + drinking water treatment' or '6-23 month complementary feeding + maternal education'. The terms were used to search scientific literature databases including PubMed, the Cochrane Central Register of Controlled Trials (CENTRAL), Jstor, Inter-Science (Wiley) and ScienceDirect. Findings were drawn from meta-reviews, randomized control trials (RCT), cluster randomized trials (C-RCT), cross-sectional surveys and intervention studies (provided they included details on the pre and post intervention). Selected studies had to identify the location of the trial as well as the sample size used¹ but without restriction on the geographic location.

A snowballing process was applied for retrieving more literature from the reference lists of relevant studies and major meta-reviews. Further studies were made available through contacts with experts working in the areas of nutrition in relevant sectors and/or with expertise on key programmatic areas (e.g. safety nets, food safety, etc.) and/or topics (e.g. women's empowerment, equity, governance).

This Chapter also includes a co-authored study (Fanzo et al. 2014) that consists of a cross-country secondary data analysis based on regressions from multiple data sources to explore statistically significant associations between nutrition-relevant outcomes and determinants influenced by sectoral policies and programs. Secondary data for the regression analysis were accessed from the Nutrition Landscape Information System (NLIS). Sources include the World Health Organization (WHO), United Nations Children's Fund (UNICEF), UN Statistics Division, UN Development Programme (UNDP), Food and Agriculture Organization of the UN (FAO), Demographic and Health Surveys (DHS)², the World Bank, International Food Policy Research Institute (IFPRI), and the International Labour Organization (ILO). Data on scale and coverage were accessed from the WHO Global database on the Implementation of Nutrition Action (GINA), which has been launched in November 2013. Data on agriculture, production and food supply were accessed from FAOSTAT. The Food Security Index data from the Economist Intelligence Unit was used to access data on nutritional quality, crop storage facilities, access to finance, road and port infrastructure, agricultural research and development investment. The World Bank database was used for socio-economic data.

¹ Studies could be from high, middle or low income countries.

² The Demographic Health Surveys (DHS) are a highly regarded survey instrument conducted in around 60 low and middle income countries, and greatly refined over time. In addition to a wide range of demographic and health variables, the DHS for some years now have collected anthropometric data for children and mothers, as well as a range of IYCF practices, women's dietary diversity (very few countries), a household asset index, access to drinking water sources and sanitation facilities, hygiene and hand-washing practices and various other household characteristics.

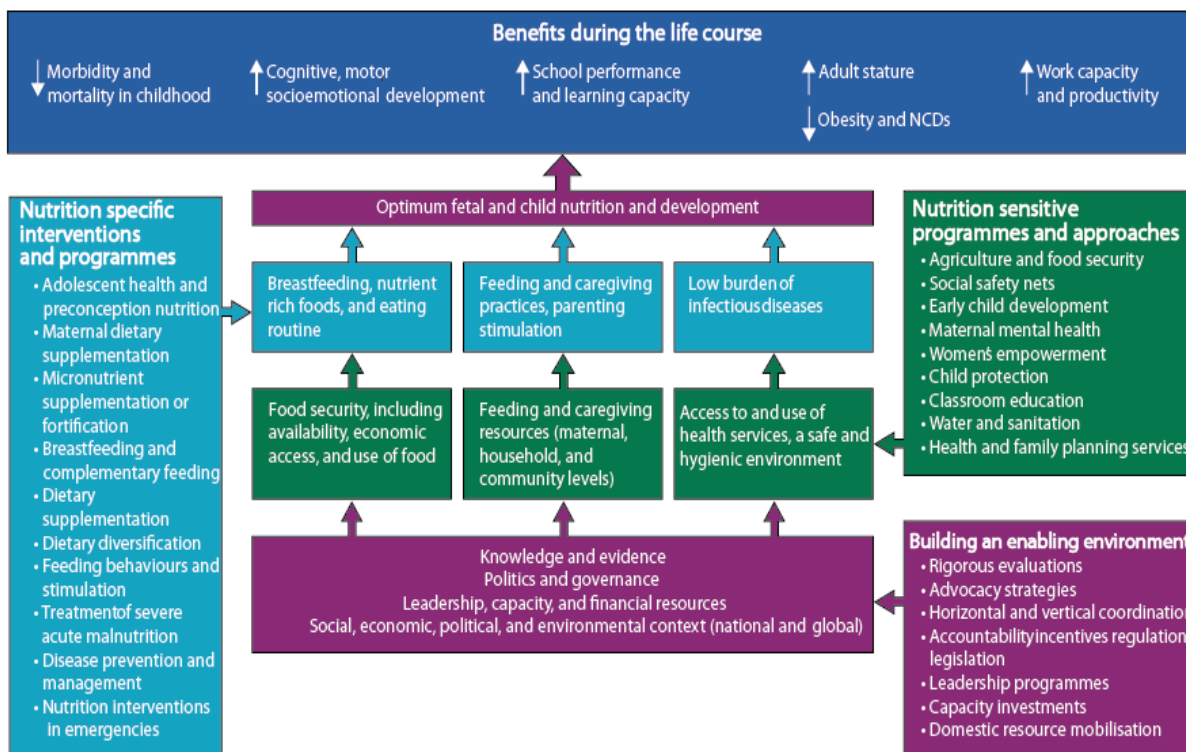
The following data sources were used for the research:

- Global database on the Implementation of Nutrition Action (GINA) www.who.int/nutrition/gina
- Nutrition Landscape Information System (NLIS) www.who.int/nutrition/nlis/en/
- Vitamin and Mineral Nutrition Information System (VMNIS) www.who.int/vmnis/en/
- WHO Global Database on Child Growth and Malnutrition www.who.int/nutgrowthdb/en/
- WHO Global Data Bank on Infant and Young Child Feeding www.who.int/nutrition/databases/infantfeeding/en/
- FAOSTAT www.faostat3.fao.org
- The World Bank database www.databank.worldbank.org/data/home.aspx

2.2 The conceptual framework

The research uses the 2013 Lancet conceptual framework for the actions to achieve optimal foetal and child nutrition. This framework is an adaptation from the original one developed by UNICEF in 1990, which identified the immediate, underlying and basic causes of child malnutrition. The 2013 Lancet framework lists a set of nutrition specific interventions and programmes that aim to improve the maternal and child dietary intake and the feeding and care giving practices as well as to treat infectious diseases. These interventions are delivered primarily through the health sector. The underlying causes of child malnutrition are embedded in the household and community level context. These underlying causes are affected by policy decisions in the domains of agriculture, drinking water supply and sanitation, health services, social protection, education and gender issues. Decisions on interventions and programmes are rooted in the social, economic, political and environmental context, which is shaped by the presence of an enabling governance and stewardship.

Figure 1: Framework for actions to achieve optimal foetal and child nutrition



Source: 2013 Lancet Series on Maternal and Child Nutrition

Given that a significant body of evidence-based recommendations already exist for nutrition specific interventions and programmes, this research explores the potential contribution of key sectors in addressing the underlying determinants of child stunting. The research builds on the most updated findings from sectoral literature reviews and from studies on the impact pathways for nutrition. The aim of the research is to overcome the gap in the understanding and application of a multi-sectoral framing approach for nutrition, looking specifically at the child stunting problem, its immediate and underlying determinants and the contribution each sector can bring through their interventions and programmes. Increasing the understanding of the underlying determinants can help to increase the use of geographic and demographic targeting of sectoral programmes and approaches to reach populations where service coverage is low and child stunting is high.

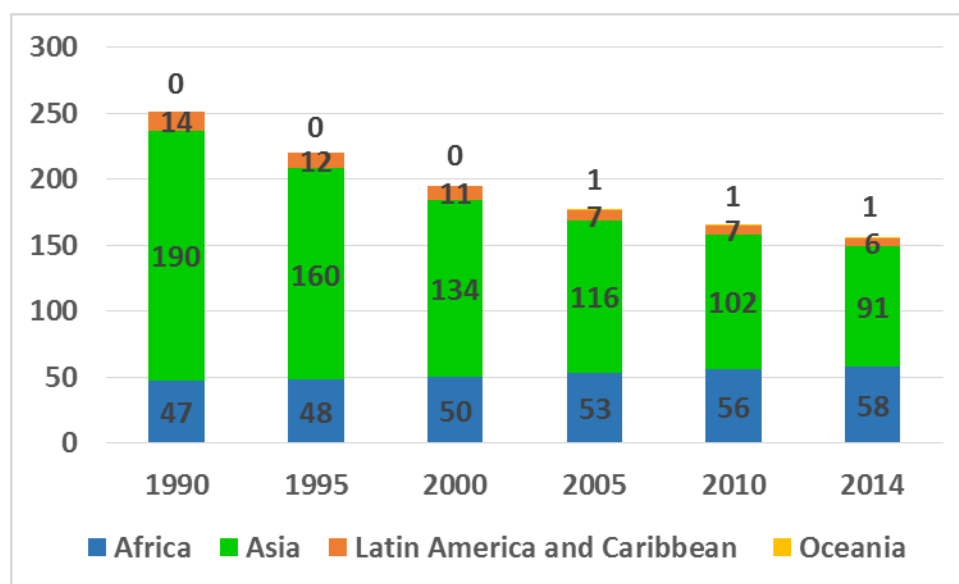
2.3 Defining the problem: under-five child stunting and immediate determinants

This research focuses on the problem of the stunting of linear growth of children younger than five years. Stunting (too short for the age) is a measure of nutrition status, marking chronic malnutrition as opposed to wasting (too thin for the height), which indicates acute malnutrition. Stunting is an established risk factor not only for mortality but also for poor child development. Several longitudinal studies show that stunting before two years predicts poorer cognitive and educational outcomes in later childhood and adolescence, (Walker et al. 2011;

Grantham-Mc Gregor et al. 2007) as well as loss in adult productivity and income (Haddad 2013). In addition there is growing evidence that stunting during early childhood increases the risk of obesity and being overweight later in life (Black et al. 2013).

The number of stunted children younger than 5 years has increased in Africa and Oceania. Elsewhere stunting numbers are declining. De Onis (et al.) estimated the number of stunted children to be 156 million in 2015.

Figure 2: Trends in number (millions) of stunted children younger than five years affected by region in the world



Source: Haddad et al. 2016

Changes in stunting prevalence have been driven by a wide range of determinants, depending on the specific context. Examples from countries that have seen a decline in their child stunting prevalence include improvements in maternal and child service coverage and in exclusive breastfeeding practices, increased access to improved water and sanitation, reduction in the prevalence of food insecure households as well as income inequality and rise in female secondary education (Haddad et al. 2014, 2015 and 2016). While the Gross Domestic Product (GDP) is recognized as a confounding factor in key determinants of child nutrition, stunting rates remain surprisingly high in several countries with robust economic and agricultural growth. This paradoxical situation of economic growth and stunting is starkly evident in India, as well as in many other countries (World Bank 2013).

From the 114 countries with available data, globally there are 41 countries on course for reducing child stunting prevalence. However, according to the most recent data (Haddad et al. 2016), 73 and 63 countries are respectively above the public health thresholds in the prevalence of stunting ($\geq 20\%$) and in the prevalence of wasting ($\geq 5\%$). Wasting and stunting can co-exist in the same child, not only during a humanitarian crisis. A recent study by (Khara

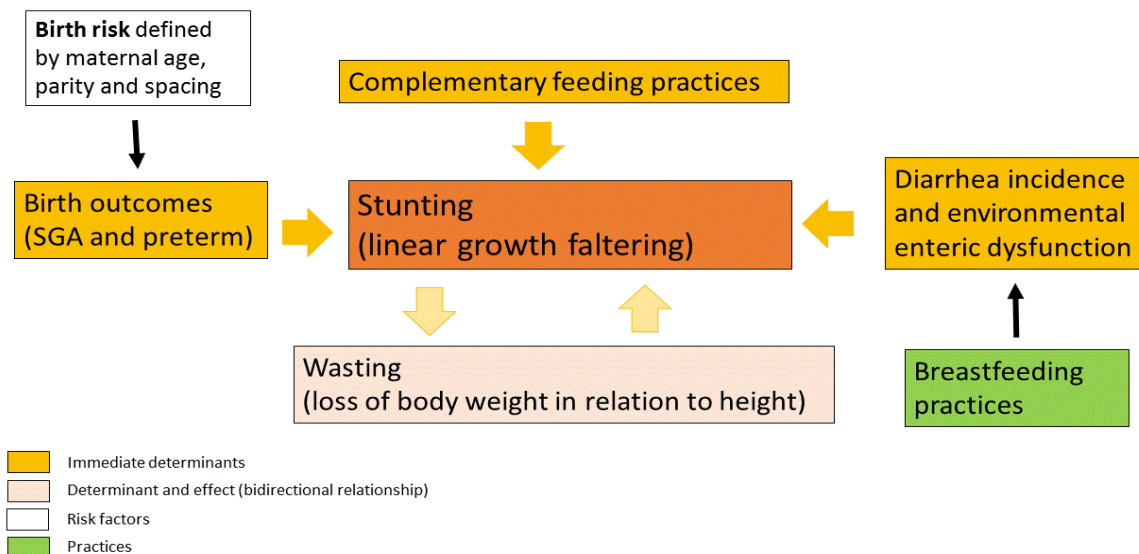
and Dolan 2014) shows the bi-directional relationship between stunting and wasting and examines the multifaceted processes and factors from which they result.

Evidence shows the importance of the nutritional status of women at the time of conception and during pregnancy for ensuring healthy foetal growth and development (Oezaltin et al. 2010). Neonates with foetal growth restriction are at substantially increased risk of being stunted at 24 months. Based on data from 19 birth cohort studies used in a meta-analysis to examine the odds for stunting, Black et al. (2013) estimated that about a fifth of childhood stunting could have its origin in the foetal period, as shown by being born small for gestational age (SGA) and preterm. Birth outcomes are strongly associated with risk factors defined by maternal age, parity and birth spacing.

Studies have consistently shown that diarrhoea is the most important infectious disease determinant of stunting of linear growth. A pooled analysis (Checkley et al. 2008) of nine community-based studies in low-income countries shows that the odds of stunting at 24 months of age increased multiplicatively with each diarrhoea episode or day of diarrhoea before that age. The proportion of stunting attributed to five previous episodes of diarrhoea was 25% (95% CI 8-38). Evidence indicates that diarrhoea leads to under-nutrition but under-nutrition also aggravates the occurrence of diarrhoea (Kothari et al. 2014). Emerging evidence links nutrient malabsorption and child stunting directly to poor sanitary and hygiene (Humphrey 2009; Lin et al. 2013; Spears 2013; Alzua et al. 2015). Findings from new research shows that faecal bacteria ingested in large quantities by children living in unhealthy environments causes inflammation and increased permeability of the gut. This particular ailment known as environmental enteric dysfunction implies that regardless of nutrient and caloric intake, linear growth remains blunted unless the underlying condition is treated (Korpe 2012; Prendergast et al. 2012; Prentice et al. 2013; Humphrey 2009).

Almost all stunting takes place in the first 1000 days after conception. Randomized control trials of adequate breastfeeding practices that included nutritional status outcomes did not show any effects on the linear growth of a child (Haroon et al. 2013) but showed an effect on diarrhoea morbidity and mortality (Lamberti 2013). By contrast there is strong evidence that appropriate complementary feeding practices reduces the incidence of stunting prevalence (Bhutta et al. 2013; Lassi 2013).

Figure 3: Immediate determinants, risk factors and practices associated with child stunting



Source: author

2.4 High-impact interventions on immediate determinants on child stunting

In 2008, Bhutta et al. reviewed more than 200 studies and concluded that there are eight interventions for infants and children with sufficient evidence on the reduction of under-nutrition for implementation in low-income countries with high prevalence. The *2013 Lancet Series on Maternal and Child Nutrition* corroborated most of the 2008 recommendations and included additional interventions based on the latest evidence.

Box 1: Ten interventions with evidence of highest impact on child stunting

Optimum maternal nutrition during pregnancy

1. Maternal multiple micronutrient supplements to all
2. Calcium supplementation to mothers at risk of low intake
3. Maternal balanced energy protein supplements as needed
4. Universal salt iodization

Infant and young child feeding

5. Promotion of early and exclusive breastfeeding for 6 months and continued breastfeeding for up to 24 months
6. Appropriate complementary feeding education in food secure populations and additional complementary food supplements in food insecure populations

Micronutrient supplementation in children at risk

7. Vitamin A supplementation between 6 and 59 months of age
8. Preventive zinc supplementation between 12 and 59 months of age

Management of acute malnutrition

9. Management of moderate acute malnutrition
10. Management of severe acute malnutrition

Source: 2013 Lancet Series on Maternal and Child Nutrition

Bhutta et al. (2013) estimated that by scaling up these ten interventions from present population coverage up to 90%, stunting reduction would be reduced by 20% and severe wasting by 60%. This estimation uses 2011 as the baseline and is based on 34 countries that together account for more than 90% of the global burden of stunting. This estimate is based on the Lives Saving Tool (LiST), which models the overall effect of these nutrition-specific interventions on child stunting (*Ibidem*)³. The additional cost of achieving the 90% coverage level for the ten interventions was calculated to be US\$ 9.6 billion per year (Bhutta et al. 2013). The economic benefit–cost ratios was estimated at approximately US\$16 for every dollar invested (Hoddinott et al. 2012 and 2013). Investing in nutrition is considered highly competitive compared with other public investments (Copenhagen Consensus 2012).

The interventions with a direct impact on child stunting are: promotion of appropriate complementary feeding practices for children between 6 and 23 months (Bhutta et al. 2013) and preventive zinc supplementation (Imdad et al. 2011). The interventions with an indirect impact on stunting include all the ones for optimum maternal nutrition, breastfeeding promotion, Vitamin A supplementation and management of acute malnutrition. Interventions for optimum maternal nutrition during pregnancy are required for the health of the mother and for ensuring healthy foetal growth and birth outcomes. A meta-analysis has showed that balanced energy protein supplementation can reduce risk of Small-for-Gestational Age (SGA) by 34% with more pronounced effects in malnourished women (Imdad et al. 2011). Breastfeeding, especially exclusive breastfeeding for the first six months and Vitamin A supplementation have a demonstrated effect on the reduction of mortality and morbidity (Black et al. 2013) but not on linear growth (Haroon et al. 2013). While there is substantial evidence on ‘why’ the ten interventions are noteworthy for the reduction of stunting and, especially of wasting, there are significant gaps in the actual implementation of these interventions.

A further analysis was made to examine the impact on stunting and wasting in Bangladesh, Ethiopia and Pakistan for scaling up coverage of the ten recommended interventions plus additional interventions related to optimizing birth intervals and improving water supply, sanitation and hygiene practices (Haddad et al. 2014). Results are consistent with those in Bhutta et al. (2013).

³ The Lives Saved Tool (LiST), developed by the Institute for International Programs at Johns Hopkins Bloomberg School of Public Health and funded by the Bill & Melinda Gates Foundation, is a model that estimates the impact of scaling up health and nutrition interventions on maternal, newborn, and child health. LiST is a part of Spectrum, a software package maintained by Avenir Health. The model been used for over 10 years and is regularly updated to incorporate the latest evidence from the scientific literature and household survey data. Online access: www.livessavedtool.org.

Table 1: Status of implementation and coverage of ten high-impact interventions in a cross-country analysis (192 countries)

Areas	Intervention	Status of implementation and coverage data
Maternal nutrition during pregnancy	1. Multiple micronutrient supplementation	<i>No implementation at scale.</i> National interventions focus on Iron and Folic Acid during pregnancy
	2. Balanced energy protein supplementation (providing about 25% of the total energy supplement as protein)	<i>No implementation at scale.</i> In few countries, provision of balanced energy protein supplements targeting malnourished women and food insecure areas. No data available on maternal feeding practices for most countries.
	3. Calcium supplementation	<i>No implementation at scale.</i>
	4. Universal salt iodization	<i>National scale implementation.</i> Coverage data are available on the presence of iodized salt in households for most countries in Asia and Africa but not in Europe, Latin America and Oceania
Infant and young child feeding practices	5. Promotion of breastfeeding	<i>Reported as practice.</i> Coverage data are available on exclusive breastfeeding, early breastfeeding and continued breastfeeding practices for 107 countries. No data on interventions.
	6. Complementary feeding education and supplementation for food secure and insecure population	<i>Reported as practice.</i> Coverage data are available on practices in 27 countries on Minimum Acceptable Diet (MAD) and Minimum Diet Diversity (MDD) In few countries, provision of complementary food supplements in food insecure populations is at limited scale and for a limited duration
Micronutrient provision for children	7. Vitamin A supplementation, 6-59 months	<i>National scale implementation</i> in many countries. Coverage data exist for most countries
	8. Preventative Zinc supplementation	<i>No implementation at scale.</i> National interventions focus on Zinc for treatment of diarrhoea but the coverage is very limited (<5% for 50 countries out of 58 countries with available data)
Management of acute malnutrition	9. Management of moderate acute malnutrition (MAM)	<i>No implementation at scale.</i> In few countries, management of moderate acute malnutrition in food insecure areas with a limited scale and duration.
	10. Management of severe acute malnutrition (SAM)	<i>National scale implementation</i> in countries with high burden of severe wasting. Geographic data are available but not so meaningful. Direct coverage data are not national.
Optimizing birth intervals	11. Reproductive health services	<i>National scale implementation.</i> Coverage data are available on uptake of modern contraceptives for most countries
Water Access, Sanitation and Hygiene	12. WASH interventions: <ul style="list-style-type: none"> • Improved water supply • Improved sanitation facilities • Hygiene practices 	<i>National scale implementation.</i> Coverage data are available for improved water sources and improved sanitation for most countries. Data on hand-washing and other hygiene practices is available for few countries only.

Adapted from Haddad et al. (2014)

2.4.1 Status of infant and young child feeding practices and factors affecting their uptake

In 2012, the World Health Assembly established the global target to increase the rate of exclusive breastfeeding (EBF) in the first six months from the current 38% to up to at least 50% by 2025. Of the 107 countries with data, 59 countries are showing some progress with an annual average rate of increase of over 2%. Some countries like Thailand, Bangladesh, Cote d'Ivoire, Dominican Republic and Burkina Faso had very rapid increases in rates, although often from low baselines. In general there is a wide variation in country progress that needs to be better understood and offers much scope for learning between countries (Haddad et al. 2014).

Literature on the effect of maternal education levels on exclusive breastfeeding practices (EBF) provides mixed results. A study in Ghana found that mothers with less than a secondary education were half as likely to exclusively breastfeed as compared to those with at least secondary education (Aidam et al. 2005). Likewise, others studies stressed that in Nigerian semi-urban setting, low maternal educational status was significantly associated with failure to breastfeed exclusively during the first six months (Ogunlesi 2010). In similar studies in Sri Lanka, Ethiopia, and Iran, maternal educational status did not show any significant association with exclusive breastfeeding (Perera et al. 2012; Setegn et al. 2012; Olang et al. 2012).

Cordova do Espirito Santo et al. (2007) found that the influence of maternal age on exclusive breastfeeding duration varies depending on culture, access to information, and characteristics of each study population. In high-income countries, adolescent mothers and those in low-wealth quintiles, or those who ceased full-time education at an early age are least likely to either start breastfeeding or continue to breastfeed for at least six months (Hamlyn 2002). In low and middle-income countries, more affluent groups may have lower breastfeeding rates (Chhabra 1998).

Returning to work after maternity leave has been identified as a significant cause for stopping or never starting breastfeeding in countries with high female labour participation (Bick et al. 1998; Baker et al. 2008; Agunbiade et al. 2012; Perera et al. 2012; Ogbuanu et al. 2011). In Canada, a reform which extended maternity leave from 6 months to 1 year, showed that breastfeeding increased 10 days with every additional month not at work (elasticity⁴ of 0.458) (Baker et al. 2008). The proportion of women attaining 6 months of exclusive breastfeeding increased about 8-9 percentage points over a pre-reform mean (Baker et al. 2008). In most low-income countries maternity leave is limited to formal sector employment or not always provided in practice (Koujianou et al. 2003; Ogbuanu et al. 2011, Ruhm 2011).

Fanzo et al. (2014) analyzed the relationship between exclusive breastfeeding up to six months and a number of independent variables to look at differences across countries with available comparable data. The table below shows the factors that together explain 31% of the variation of the exclusive breastfeeding prevalence across 109 countries with available data.

⁴ Elasticity is defined as the degree to which a dependent variable (in this case breastfeeding) changes in response to an associated independent variable (in this case months of maternity leave).

Table 2: Factors explaining the variation of the exclusive breastfeeding prevalence among children below 6 months of age in a cross-country analysis (109 countries)

Factor	Association with exclusive breastfeeding (EBF)	Effect on EBF
Income	Each \$1,000 increase in GNI per capita (US\$ PPP) is associated with 0.01% increase in EBF (95% CIs: 0.0001, 1.84)	↗
Adolescent birth rate	Each 1% increase in adolescent birth rate is associated with 0.10 % decrease in EBF (95% CIs: -0.21, 0.03)	↘
Maternity leave and female labour participation	The importance of maternity leave as a predictor for EBF increases only for countries with higher female to male ratio of labour participation (95% CIs: -10.79,-1.60)	↗

Source: Fanzo et al. (2014)

Practices relating to complementary feeding programmes include minimum acceptable diet and minimum diet diversity indicators for children between 6 and 23 month old⁵. Although the median for the 27⁶ countries with comparable data is low (15% for minimum acceptable diet and 27% for minimum diet diversity) there is a wide variation between countries as shown in Table number 3.

Table 3: Percentage of young children between 6 and 23 months of age receiving a minimum acceptable diet and a minimum dietary diversity in 27 countries with data

	Percentage of young children, 6-23 months, with:	
	Minimum Acceptable Diet (MAD)	Minimum Dietary Diversity (MDD)
Median	15	27
Minimum	3.1	4.8
Maximum	54.2	67.7
Number of countries with available data	27	27

Source: Haddad et al. (2014); Data from DHS surveys conducted between 2010 and 2013

The association of correct initiation of complementary feeding with maternal socio-economic status and formal education levels (i.e. levels of primary and secondary schooling) has been found to be statistically significant in a number of studies (Rao et al. 2011; Semba et al. 2008, Chou et al. 2011). Several studies also concur with the finding that female secondary education enhances women's access and use of reproductive health services, which in turn are positively

⁵ Minimum Dietary Diversity (%): Proportion of children 6–23 months of age who receive foods from four or more food groups. Minimum Acceptable Diet (%): The composite indicator is calculated from: The proportion of breastfed children aged 6–23 months who had at least the minimum dietary diversity and the minimum meal frequency during the previous day, and the proportion of non-breastfed children aged 6–23 months who received at least two milk feedings and had at least the minimum dietary diversity not including milk feeds and the minimum meal frequency during the previous day. (WHO 2008. Indicators for assessing infant and young child feeding practices. *Part 1 Definitions* http://whqlibdoc.who.int/publications/2008/9789241596664_eng.pdf, Accessed 3 September 2014).

⁶ Only surveys from 27 countries met the two latest criteria introduced by WHO. The criteria for Minimum Dietary Diversity was changed to 4+ food groups for all breastfed and non-breastfed children aged 6-23 months to reflect the quality of complementary feeding. In addition, 'eggs' were counted as a food group separate to poultry.

associated with maternal parity and adequate child spacing (Westoff 1988; Al Riyami et al. 2004; Ahmed et al. 2010; Baird et al. 2010).

Fanzo et al. (2014) analyzed the relationship between the minimum acceptable diet as the dependent variable and a number of independent variables to look at differences across countries with available comparable data. The table below shows the variables that together explain 59% of the variation of the minimum acceptable diet across 27 countries with available data. With respect to child stunting, the minimum acceptable diet is an immediate determinant (or likely cause) while income and female education are underlying determinants (or likely correlates).

Table 4: Factors explaining the variation of minimum acceptable diet prevalence among children between 6 and 23 months of age in a cross-country analysis (27 countries)

Factor	Association with minimum acceptable diet (MAD)	Effect on MAD
Income	Each \$0.01 increase in GNI per capita (US\$ PPP) is associated with 8.6% increase in the percentage of children aged 6 to 23 months receiving a minimum acceptable diet (95% CI: 0.022, 0.3295).	↗
Female education	Each 1% increase in female to male adult literacy rate is associated with 0.24% increase in the percentage of children aged 6 to 24 months receiving a minimum acceptable diet (95% CI: 0.004, 0.48).	↗

Source: Fanzo et al. (2014)

2.5 The role of the health sector

The delivery of most of the high-impact nutrition interventions identified by the 2008 and 2013 Lancet Series (Bhutta et al. 2008 and 2013) relies heavily on functioning health facilities, services and personnel. In countries where government health services provide wide coverage and are easily accessible, health services are a logical and sustainable channel for nutrition interventions (Penny et al. 2005). In contexts where access to primary health care facilities is difficult, community health workers (or frontline health workers) are also increasingly being used for the delivery of home-based health interventions (*Ibidem*).

2.5.1 Evidence of health interventions on exclusive breastfeeding practices

The reasons for low prevalence of exclusive breastfeeding include the lack of support by health care providers; emotional stress in mothers and their perceptions of not having enough breast milk; pressure from close relatives to introduce other liquids and solid foods; maternal employment; unsupportive hospital practices that delay early initiation of breastfeeding; and commercial advertising of breast milk substitutes including through hospitals (Froozani et al. 1999; Britton et al. 2007; Declercq et al. 2009; Dungy et al. 1997; Rosenberg et al. 2008).

In one of the most important meta-analysis reviews of 110 Randomized Control Trials and quasi experimental studies, Imdad et al. (2011) looked at the impact of breastfeeding promotional

strategies on exclusive breastfeeding rates at four weeks, at six weeks, and at six months. On the whole they found that breastfeeding promotion techniques led to an overall 137% increase, with a significant six times increase in exclusive breastfeeding in low-income countries, compared to 1.3 fold increase in high-income countries.

Imdad et al. (2011) identified the Baby Friendly Hospital Initiative and the use of counselling as the two most common approaches to promote exclusive breastfeeding. The Baby Friendly Hospital Initiative (BFHI) is a highly debated facility based promotion techniques in the literature (Perrine et al. 2012; Sheryl et al. 2011). The Baby Friendly Hospital Initiative, launched in 1991, is an effort by UNICEF and the World Health Organization to ensure that all maternities, whether independent or in a hospital, become centres of breastfeeding support (UNICEF, 2013). The initiative is based on the premise that hospitals and maternity units can set a powerful example for new mothers. To officially qualify as a BFHI, facilities must comply with the ten specific steps to promote breastfeeding. The process is controlled by national health authorities using standard global criteria that can be applied to maternity care in every country. The BFHI combines practical training of health professionals to support early initiation and exclusive breastfeeding with the enactment of the International Code of Marketing of Breast-milk Substitutes.

In their meta-analyses, Imdad et al. used country-level data to examine the relationship between BFHI programming and trends in exclusive breastfeeding in 14 low-income countries. Through analysis of trends before and after the implementation of the BFHI, they found that BFHI implementation was associated with average annual increases of 1.11 percentage points in the rate of EBF of infants under six months ($p < 0.001$). According to Abrahams et al. (2009) a country that implements the BFHI would experience on average, a 5.5 percentage point increase in EBF over a subsequent five year period. The effectiveness of BFHI has been questioned recently and there has been a reduction in international support for this program. The 2012 World Breastfeeding Trend Initiative (WBTi) report that of the 51 countries that are implementing BFHI, only China, Fiji and Philippines have all government hospitals accredited as Baby Friendly.

Meta-analyses suggest that group-counselling to promote breastfeeding was associated with increased odds of exclusive breastfeeding by a factor of 5.2 at six months compared with routine care. By contrast, individual counselling was estimated to raise the probability of exclusive breastfeeding by a factor of 1.9 at six months compared with routine care (Bhutta et al. 2011). The 2013 Lancet series concluded that combined individual and group counselling at facility level appeared to be superior to individual or group counselling alone (Bhutta et al. 2013).

Several publications have evaluated different types of breastfeeding peer-counselling models (Dennis et al. 2009; Agrasada et al. 2005; Chapman et al. 2004; Haider et al. 2000; Leite et al. 2005; Morrow et al. 1999; Nankunda et al. 2006; Graffy et al. 2004; Muirhead et al. 2006). Definitions of peer-counselling vary between publications but breastfeeding peer-counsellors

are generally considered to be local community women who have successfully breastfed, received training in breastfeeding education, and work with their peers to improve breastfeeding outcomes (Chapman et al. 2010). Chapman et al. systematically reviewed randomized trials that had assessed the effectiveness of breastfeeding peer-counselling. Twenty-six peer-reviewed publications were examined in their review, and included populations from low and middle-high income countries. The overwhelming majority of evidence from the randomized controlled trials evaluating breastfeeding peer-counselling indicates that peer-counsellors effectively improve rates of breastfeeding early initiation, duration and exclusivity.

Fanzo et al. (2014) looked at the effect of peer-counselling and facility-based promotion on the likelihood of exclusive breastfeeding up to six months. They found that mothers who received peer-counselling were 2.46 times (95% CI 1.99-3.04) more likely to exclusively breastfeed compared with the control group. For facility-based promotion, the likelihood was less strong but still significant at 1.55 times higher. They then assessed the circumstances in which both interventions could be most effective. In order to do this, they applied to the model a set of specific child, maternal and household characteristics. Both peer-counselling and facility-based promotion had a similar highest effect where female labor participation rate is below 40%. However, only peer-counselling had the highest effect in countries where the maternity leave duration is less than 12 weeks. The effect of peer-counselling was found to be double for mothers that exclusively breastfeed for four months or more compared with the mothers that exclusively breastfed for three months or less. No significant difference was noted for facility-based promotion on the duration of exclusive breastfeeding. Both peer-counselling and facility-based promotion had the highest effect in countries where rural populations are 30% or more. Peer-counselling only had the highest effect where the ratio of female literacy rate to male literacy rate for the age group 15-24 years is lower than 80%, while no significant difference was noted for facility-based promotion.

Whilst a large number of studies have shown the effectiveness and impact of peer-counselling on exclusive breastfeeding rates, most investigations have been conducted in quite small populations (Bhutta, 2011). It is therefore uncertain whether the same results can be readily achieved at large scale and under which circumstances peer-counselling is most effective.

2.5.2 Evidence of health interventions on complementary feeding practices

According to the World Health Organization, the complementary feeding of young children aged 6-23 months should be *timely*, *adequate* and *appropriate*. The health sector has employed several approaches to improve complementary feeding practices, looking not only at the quality and quantity of foods but also at the feeding practices (Imdad et al. 2011; Caulfield et al. 1999). Approaches include nutritional counselling for mothers and the provision of complementary food supplements either fortified with multiple micronutrients or with increased energy content. Health facilities, clinics, community health workers and health outposts with trained staff can all serve as a delivery channel for both the provision of food supplements as well as for

the education and counselling on feeding practices (Ruel 2013). A study by Sunguya et al. (2013) shows the benefits of using national-wide training for health workers as an entry point to improve the promotion of complementary feeding practices.

In another meta-analysis, Imdad (2011) conducted a systematic review to evaluate the two most commonly applied approaches to promote adequate complementary feeding. These included the timely provision of appropriate complementary food supplements (with or without nutritional counselling) and the education to mothers about practices of complementary feeding on growth. In line with the 2008 Lancet series and with Dewey et al. (2008 and 2009), findings show that both approaches were found to have a significant impact on growth and weight of young children aged 6-23 months. It was also found that the educational interventions with the most prominent impact on child growth were those that put emphasis on feeding nutrient-rich animal source foods (Imdad, 2011). Although counselling or nutritional education does not need to be channelled exclusively through the public health sector, health-based facilities, services and frontline health workers are the most commonly used delivery platforms. Types of interventions that are analysed in the literature include maternal counselling and education through peer-counsellors and health workers, and health professional training and provision of food supplements often supported by nutrition education.

Besides the lack of substantial published literature on complementary feeding interventions (Dewey et al. 2008; Bhutta et al. 2013), the data that can be analyzed is further reduced by the differences in the categorization of outcome variables, which hinder cross-comparisons between studies (Fanzo et al. 2014). There is a large variety of outcome measures in the literature when looking at complementary feeding, including: energy protein adequacy, energy, protein, zinc, iron and daily fat intake, meal frequency, health eating index score, feeding specific food groups, number of children fed with certain food groups, displays of positive feeding patterns, haemoglobin levels, anaemia prevalence, iron and vitamin A deficiency, introduction of solid and semi-solid foods, minimum dietary diversity for breastfed and non-breastfed babies, and minimum acceptable diet for breastfed and non-breastfed babies. Studies are therefore too heterogeneous to conduct meta-analysis.

2.5.3 Evidence of health interventions on women's reproductive practices

Birth outcomes are associated with maternal age, parity and birth spacing (Black et al. 2013). An estimated 222 million women in low-income countries have unmet needs for modern contraceptive methods (WHO 2013). The provision of access to voluntary family planning is not only crucial to directly improve reproductive health outcomes but is also positively associated with improvements in female health, schooling, and economic outcomes (Darroch 2013). In most low-income countries, the health sector provides the only delivery channels for family planning methods in the form of the direct provision of contraceptive products and/or through the counselling on family planning options and the associated benefits of birth spacing.

Studies show that many women do not use contraception because of poor understanding of their risk for pregnancy, health concerns about potential side effects, or opposition from male partners (Sedgh et al. 2007). As Darroch pointed out, married women might have little or no control over contraceptive decision making and unmarried women often face strong stigma if they are sexually active, which in turn reduces young women's ability to obtain needed services at health facilities. It is widely documented that to impact fertility rates and contraceptive use, emphasis needs to be placed on the *quality* of services, including offering a range of methods to meet the different needs of women and couples, ensuring voluntary choice of methods, training staff to increase provision of accurate information and confidential and respectful care, giving priority to adequate counselling and follow-up care, and facilitating switching methods (Darroch 2013).

The common outcome indicator for trials in low and middle-income countries is contraceptive use. Fertility rate is not tracked as extensively in the published trials. The literature suggests that contraceptive uptake can be provided for in a variety of ways, the most appropriate or effective of which will depend on the context-specificity, particularly in view of the fact that women are influenced by a myriad of factors operating at the individual, family, school, community, and societal levels (Speizer et al. 2003).

The meta-analysis of sixteen trials targeting adolescent girls through different approaches found that the likelihood of using contraceptive was 1.16 times (95% CI: 1.01 to 1.35) higher among girls that had been exposed to school education, media campaigns and community-based education (Fanzo et al. 2014). Female secondary school enrolment as percentage of male enrolment was included in the model and showed that one unit increase in female enrolment corresponds to a change of 0.98 in the average rate of contraceptive use. This finding is consistent with what has been widely noted in the literature. By closing the gender gap in education, women can enhance their access to reproductive health services (Westoff 1988; Al Riyami et al. 2004; Ahmed et al. 2010; Baird et al. 2010). A higher percentage of female to male secondary school enrolment can explain 59% (95% CI: 0.26 to 0.69) of the variation in contraceptive use in cross-country simulations (Fanzo et al. 2014),

2.6 The role of the agriculture sector

According to Doward (2013), the most effective pathways for improving people's diets change with economic growth, with declining importance of the own production of foods and increasing reliance on the market.

Several studies identified seven main pathways through which agriculture influences nutrition outcomes (Headey et al. 2011; Gillespie et al. 2012; Ruel 2013; Herforth et al. 2012, Webb 2013).

Box 2: Pathways through which agriculture interventions influence nutrition outcomes

1. Agriculture as a source of food (production translating into consumption).
2. Agriculture as a source of income (through wages earned or marketed sales).
3. Agricultural policy and food prices (market policy, price setting and price volatility).
4. Agricultural income spending (non-food expenditure relating to nutrition and health).
5. Women's status and control over resources (relating to food, health, and care).
6. Women's time and knowledge (ability to care, feed and promote health).
7. Women's nutrition and health (energy expenditure, healthy pregnancy and longevity)

Source: Gillespie et al. 2012

The current literature concurs that women - their social status, empowerment, control over resources, time allocation, and health and nutritional status - are key mediators in the pathways between agriculture inputs, intra household resource allocation and child nutrition (Ruel 2013). Pro-women targeted approaches therefore play a critical role in nutrition sensitive agriculture. However very few studies have measured the effect of agriculture interventions on women's time, knowledge, practices, health, or nutritional status and none has modelled the potential mediating role of these maternal factors on child nutrition (Ruel 2013).

Agricultural investments impact diets through a combination of the multiple pathways outlined above (e.g. as a source of food and income while empowering woman) and mostly engage a combination of delivery channels rather than just one: community based approaches, national public programs, private sector and legislation.

The overall stage of economic development (described by Gross National Income (GNI) per capita) and the role of agriculture in society (described by the percentage of rural population, the employment rate in agriculture, and the value added to the national income by agriculture), determine how important agriculture is as an economic driver, and how transformations in agriculture will affect nutrition outcomes (Doward 2013).

2.6.1 Evidence of agriculture interventions on maternal and young child diets

In general, the majority of studies that include diet as an outcome find a positive impact on the consumption of specific foods promoted in the agricultural interventions. Home garden interventions increase the consumption of fruit and vegetables, particularly of foods rich in Vitamin A for both women and children (Girard et al. 2012); aquaculture and small fisheries interventions increase the consumption of fish, and dairy development intervention increases the consumption of milk. There are few exceptions where no changes were observed (Masset et al. 2012).

While the promotion of bio-fortified crops can provide about 50% or more of daily micronutrient needs, it cannot substitute direct supplementation for pregnant women and young children due to their requirements for high-concentrations of micronutrients (Ruel et al. 2013).

One difficulty in interpreting the results of these studies is that they only focus on the impact on the consumption of the food items that are targeted by the intervention (for example fish, eggs or sweet potato) thus ignoring substitution effects in consumption. So while the interventions appear to be successful in promoting the consumption of food rich in protein and micronutrients, the effect on the overall diet remains unclear.

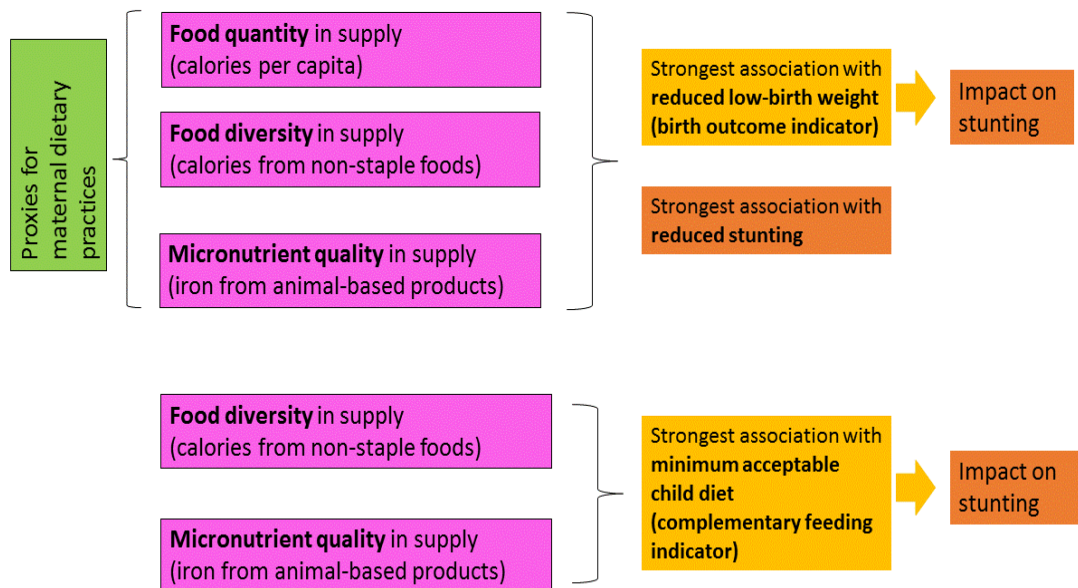
Studies available from the literature are all community-based approaches that are implemented on a very small scale, often with external funding and within a limited duration. The effect on maternal and child diet of national agriculture subsidy policies or large extension programmes is largely unknown due to the paucity of published literature (Hawkes et al. 2012, 2011, 2006). It has been argued that incentives to increase productivity of major grains might lead to a shift from diversified cropping systems towards ecologically more simple cereal based systems, which could in principle contribute to poor diet diversity (Frison et al. 2006; Graham et al. 2007). On the other hand, when prices of major staples increase, like during the food crisis of 2008, it is observed that the percentage of food expenditures for nutrient rich products like animal-based resources, fruits and vegetables decreases (Bouis et al. 2011).

To overcome the limitations in the literature, Remans et al. (2014) developed a model to identify the determinants that are most strongly associated with child stunting and are also meaningful from the point of view of the agriculture sector.

For maternal diet, three dietary determinants were identified as most strongly associated with child stunting in a cross-country analysis (92 countries). These included: the percentage of energy from non-staples in the national food supply as an indicator for *food diversity*, the amount of calories available per capita in the national food supply as an indicator for *food quantity* and, finally, the amount of iron available from animal-based products in the national food supply as an indicator for *micronutrient quality*. The three factors are each significantly related to stunting independent from the per capita income level of a country and independent from each other. The analysis also showed that the percentage of energy from non-staples was strongly associated to low-birth weight prevalence suggesting that part of the contribution of diet diversification to lower stunting rates could be explained through improved birth outcomes.

The Minimum Acceptable Diet (MAD) was used as the indicator for appropriate complementary feeding among children between 6 and 23 months of age in a cross-country analysis (32 countries). The amount of iron available from animal-based products in the national food supply, and the food diversity in supply, was significantly related to the minimum acceptable diet indicator.

Figure 4: Determinants of the diet among pregnant and lactating women and among children between 6 and 23 months of age that are associated with child stunting in a cross-country analysis (98 countries for the maternal diet and 32 countries for the child diet)



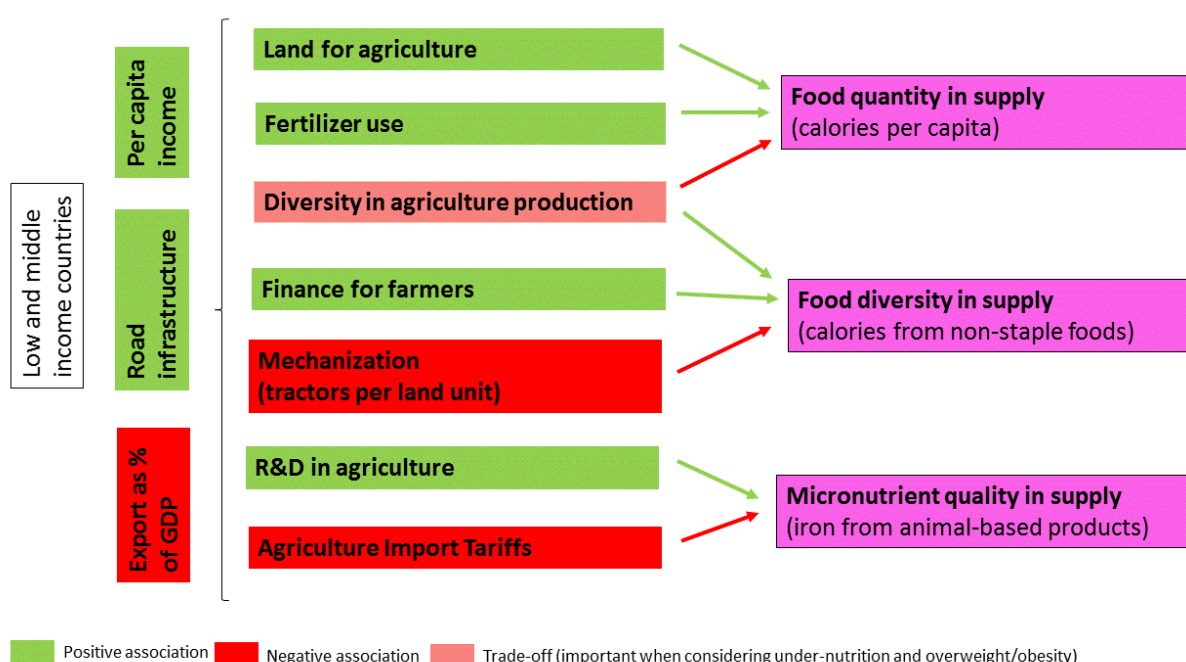
Source: Adapted from Remans et al. (2014); Presented in Fanzo et al. (2014)

Remans et al. (2014) analysed the associations between the identified determinants and a number of agriculture factors as independent variables, controlling for the economic stage of development as defined by the Log GNI per capita, the road infrastructure, and the exports as percentage of GDP. The results show that in low and middle-income countries, national supply diversity is positively associated with domestic production diversity and access to finance by farmers, while it is negatively related with agriculture mechanization. The amount of fertilizer used per unit of land and the percentage of land used for agriculture are found to contribute positively to the amount of calories available per capita in food supply. On the other hand, there is a negative relationship between diversity and quantity in food supply. For iron availability from animal-based products, a negative association is found with agricultural import tariffs, and a positive one with public investment in agricultural research and development. No direct relation was found with the number of animals available per capita.

Finally, the same model was used by Remans et al. (2014) to identify agricultural indicators related to the MAD prevalence among children between 6 and 23 months of age. However, the findings should be interpreted with care due to only 32 countries included in the analysis. Higher diversity in food production and iron availability from animal based products in the national food supply were also found to be significantly and positively associated with MAD prevalence. This finding is consistent with other studies that have described the significant

relationship between access to animal-based products as a source of both iron and animal proteins, and improved child diet in low-resource settings (Murphy et al. 2003, Leroy et al. 2007).

Figure 5: Agriculture factors associated with the determinants of the diet among pregnant and lactating women and among children between 6 and 23 months of age in a cross-country analysis (98 countries for the maternal diet and 32 countries for the child diet)



Source: Adapted from Remans et al. (2014); Presented in Fanzo et al. (2014)

Taken together, the results of these agricultural models, identify four promising areas for nutrition-sensitive agricultural investments: agricultural diversification, access to finance for farmers, investment in Research & Development (R&D) and improved fertilizer use.

Substantial literature is available about specific agricultural interventions that can contribute to the four identified promising areas. For agricultural diversification, one of the most studied nutrition-sensitive interventions includes diversified homestead gardens, for which positive effects on diet diversity and women income generation has been described in numerous research papers. The promotion of animal production (Leroy et al. 2007; Kwarazuka 2010) and specific nutrient-dense vegetables and fruits (Ruel 2001; Smith et al. 2007; Masset et al. 2011) has proven to increase consumption of these specific products but the effect on the overall diet remains unclear. More recently, studies have shown a positive effect of agro-forestry and legume intercropping on diet diversity (Jamnadass et al. 2013). Finally, small-scale irrigation is essential to facilitate many of the agricultural diversification interventions mentioned above (Domenech 2013). For access to finance for farmers, a number of studies have looked at the

impact of social cash transfers on diet diversity, especially when combined with nutrition education (see social protection section). Fertilizer use represents a significant public agriculture investment in many low and middle income countries (Graham et al. 2007; Denning et al. 2009). Bio-fortification of local staple crops shown to lead to increased micronutrient intake represents a promising area of agricultural R&D (Bouis et al. 2010; Ruel 2013).

Several studies, particularly from the 1980's and 1990's and some new recent studies (Wood et al. 2013) describe that the transition from subsistence farming to commercial agriculture can lead to the risk that the nutritious food items are exported as cash crops - leading to a decrease in access and utilization by the local households. Managing such transitions carefully can have important implications for the diet diversity and related health outcomes (Webb 2010). According to Webb (2012), options to reduce the risk of this trade-off include engaging women in agriculture activities that generate income, supporting access and trade of nutritious food items in local small markets and promoting nutrition education at the population level.

2.6.2 Evidence of agriculture interventions on contamination of drinking water and foods

Agriculture has an important role to play on the prevention and management of foodborne diseases through improved safety of drinking water and foods.

Improper agricultural methods can elevate concentrations of nutrients, fecal coliforms, and sediment loads. Increased nutrient loading from animal waste can lead to eutrophication of water bodies that may eventually damage aquatic ecosystems. Animal waste may also introduce toxic fecal coliforms which threaten public health. Grazing and other agriculture practices may intensify erosion processes raising sediment input to nearby water sources. Increased sediment loads make drinking water treatment more difficult while also affecting fish and macro invertebrates. Agricultural practices that help reduce negative effects on water quality include high precision agriculture, protected wells, integrated pest management, fenced grazing and other livestock management practices (Remans 2014).

A key issue in food safety is mycotoxins, which are fungal metabolites contaminating up to 25% of the human food supply. Consumption of aflatoxin-contaminated food is associated with stunting in both stature and in cognitive development and likely associated with susceptibility to disease and reduced response to vaccinations. The key period of vulnerability to mycotoxins is not clearly defined, but includes both the pre-natal and the first few years of life, however the negative effects have life-long implications for the affected children. The burden of mycotoxin exposure is particularly high in countries where the population's diet is limited to mainly a single food staple that is vulnerable to fungal infection, either in the field or during postharvest processing or storage. Among the possible agricultural interventions to tackle mycotoxin exposure are pre-harvest agricultural practices, postharvest sorting and storage practices, as well as dietary changes. Simple postharvest intervention strategies, in particular improved drying practices and storage facilities, are found successful in reducing aflatoxin

exposure in a subsistence farm setting, providing a rationale for prevention of aflatoxin-related disease (Wild, 2007).

2.7 The role of Water Access, Sanitation and Hygiene (WASH)

In the broadest sense WASH encompasses efforts to maintain an adequate water supply both in terms of quality and quantity, sufficient means of sanitation, and proper hygienic practices. In practice, WASH interventions require the collaboration of a number of technical ministries; at the minimum of the public health, infrastructure, agriculture and formal education ministries.

2.7.1 Evidence of WASH interventions on diarrheal incidence and environmental enteric dysfunction

Research evidence has shown that adequate supply of both safe (Fewtrell, 2005) and accessible (Tonglet 1992) drinking water has resulted in substantial reductions in diarrheal incidence. A meta-analysis of intervention studies shows improved water supply reduces diarrhoea by 34%, improved sanitation reduces diarrhoea by 28 % and hand washing with soap reduces diarrhoea by 40% (Freeman et al. 2014). However, there is a wide variation for different service levels, with high-quality piped water reducing diarrhoea by 79% but improved communal sources achieving only an 11% reduction. Similarly, sewerage connections can reduce diarrhoea by 69%, whereas on-site sanitation only reduces the burden by 16% (Wolf et al. 2014).

Point-of-use (POU) treatment methods are included among water quality interventions. These were popularized in the late 1990's as water improvement strategies and determined a shift from the macro to micro (village) level. Though many variations exist in terms of cost, efficacy, compliance and sustainability, one particular study found promise in a low-cost, low-maintenance practice; the use of small cotton cloths made of sari (local garment). Huq et al. (2010) measured the efficacy and sustainability of the sari cloths in Matlab, Bangladesh. Findings show that the sari cloth filter resulted in a 50% reduction in cholera infection among sari cloth users and was still in use by 31% of the households in more in 7,233 villages after five years since the practice was introduced.

From a programmatic point of view, 'sanitation' focuses on the provision and use of latrines and other facilities used for disposal of faecal matter. It involves interventions aimed at creating an environment that is clean (or less exposed) to soil and animal contaminants. Interventions include construction of septic systems, pit latrines, compost toilets and flush systems.

One rural Zimbabwean study, in particular, demonstrated that the presence of a community latrine reduced diarrheal morbidity by 68% over comparable villages. General hygiene education was provided along with the instructions on the latrine usage and maintenance. Despite the lack of complete coverage due to high costs, neighbouring communities saw diminished diarrheal rates due to cleaner inter-village environments (Root, 2001). One study in rural Mali (Alzua et al. 2015) and one study in the Indian State of Orissa (Clasen et al. 2012) came to very similar findings.

Environmental enteric dysfunction is a subclinical condition of the small intestine, characterized by reduced nutrient absorption surface area, increased intestinal permeability, and subsequent systemic inflammation (Haghighi et al. 1997). Over the past two decades, a number of studies in the Gambia have demonstrated an association between environmental enteric dysfunction and child stunting independent of diarrheal disease or poor diet (Campbell et al. 2003, Lunn et al. 1991). A study by Humphrey (2009) in Zambia suggests that environmental enteric dysfunction, caused by frequent exposure to and ingestion of fecal pathogens by young children, is the main cause of child stunting in places with poor hygiene and sanitation. Freely roaming animals are common in such settings, especially where small-holder poultry farming is the norm, contributing to high concentrations of animal feces in the environment (Marquis et al. 1990, Harvey et al. 2003, Ngure et al. 2013). Observational research has shown associations between household environmental cleanliness, such as access to water and sanitation infrastructure, biomarkers for environmental enteropathy, and standardized child height scores (Lin et al. 2013).

From a programmatic point of view, 'hygiene' refers specifically to measures set to increase the practice of hand washing with soap after defecation and disposal of child faeces prior to preparing or handling food and before eating. Substantial improvements in reduced diarrhoea prevalence have been shown through hygiene education and promotion of hand washing with soap (Cairncross 2003). According to Shahid et al. (1996), hand washing with soap offered a low-cost intervention strategy in Bangladesh that showed substantial reductions in diarrhoea occurrence despite limited increase in the overall coverage of drinking water supplies and improved sanitation facilities. Of particular note were interventions involving soap and water pitcher distribution, hand washing education before feeding children and preparing food, and hand washing following defecation. In concurrence with other hand-washing interventions (Khan 1982; Black 1981), Shahid et al. (1996) found that the most efficacious approach to reduce diarrhoea incidence was to stress hand washing after defecation and prior to meal and food handling. As shown by Cairncross, et al. (2003) in a comprehensive review of sanitation programs, hand washing could reduce diarrhoea risk by 43%. In a comparative analysis, Fanzo et al. (2014) found that mothers exposed to activities that promoted hand washing were 24% less likely to experience diarrhoea (95% CI: 0.62 to 0.93, $p=0.0074$) and mothers exposed to activities that promoted water treatment at point of use were 29% less likely to experience diarrhoea (95% CI: 0.56 to 0.90, $p=0.0043$).

Complementary foods prepared under unhygienic conditions are frequently heavily contaminated with pathogenic agents and are a major risk factor in the transmission of diseases, especially diarrhoeal diseases and may increase the exposure to environmental enteric dysfunction (Motarjemi et al. 1993). In Bangladesh, 41% of samples of complementary foods fed to children aged 6-23 months contained *E. coli* (Black et al. 1981; Black et al. 1982). In another study in Bangladesh, 900 samples of food and drinking water were analysed for faecal coliforms, and the complementary foods contained the highest levels of faecal coliforms (Henry et al. 1990). In the Gambia, a high proportion of the food consumed by infants and young

children contained pathogens (Barrel et al. 1979). In Myanmar, foods consumed by children aged 6-23 months were examined for four enteric bacterial pathogens. Of 775 samples of food tested, 505 were positive for *E. coli* (Khin Nwe et al. 1991). It should be noted that most low and middle-income countries do not have legislations in place that mandate safe processing and handling of commercial complementary foods for children aged 6-23 months (WHO 2014).

Adequate breastfeeding practices not only reduce infant exposure to water and foodborne pathogens (Bhandari et al. 2003; Davies-Adetugbo et al. 1996) but also improve infant resistance to infection through transmission of passive immunity from the mother (VanDerslice 1994). According to a study conducted among Filipino infants, the incidence of diarrhoea among non-breastfed children was nearly three times greater than that of breastfed infants (*Ibidem*).

2.7.2 Evidence of WASH interventions on child stunting

The first available evidence of a direct link (i.e., not through diarrhoea) between improved WASH and child stunting came from a meta-analysis of five cluster-randomized trials of WASH interventions (Dangour et al 2013). The interventions showing an effect on child height for age included solar disinfection of drinking water, improvement of the quality of drinking water at point of use and provision of soap.

An econometric analysis conducted by Spears et al. (2013) has demonstrated that cross-country differences in sanitation explained 54% of the variation in average height of children in Africa and Asia. In the Indian case, where open defecation is exceptionally widespread, these results suggest that this practice could directly account for much or the entire excess child stunting, especially in areas of high population density. Cross-country evidence from Lao PDR, Vietnam, and Tanzania show correlation between the ratio of households defecating in the open and those using unimproved sanitation in a community and height-for-age Z-scores (stunting) over time in children under the age of five (Hammer and Spears 2013). Additional studies have also shown the strong correlation between the prevalence of child stunting and the prevalence of households without sanitation (Quattri and Rand 2014; Quattri et al. 2014a, 2014b).

A recent policy review identifies complementary food hygiene as an overlooked measure in the WASH, nutrition and health domain (Gautam et al 2015). There is a renewed interest in the research community to isolate the effect of complementary food hygiene on nutrition outcomes. Field-based studies in Kenya, Bangladesh and Zimbabwe are expecting to look at the direct impact of WASH interventions on child linear growth through randomized controlled trials that address multiple pathways of fecal contamination including one specific pathway on complementary food hygiene. The study in Zimbabwe will capture the initial 1000-days of a child life. In addition to these clinical studies, most recent evaluation studies in the WASH sector are designed to measure the impact on child linear growth and environmental enteric dysfunction in addition to diarrheal incidence (*ibidem*).

2.8 The role of social protection

Social protection policies aim to help poor and vulnerable people to counter deprivation and reduce vulnerability to global challenges such as economic shocks, instability in the price of food or other essential commodities, and climate change. The Social Protection Floors Recommendation, 2012 (No. 202) was adopted by the International Labour Conference (ILC) in June 2012. The Recommendation expresses the commitment of Member States to build comprehensive social security systems and extend social security coverage to all in need. The establishment of social protection floors requires inter-ministerial collaboration; at the minimum among, the ministries of welfare, agriculture, public health and formal education.

Many social protection programmes are aimed at reducing household vulnerability through the provision of a transfer that helps them to smooth their consumption level over time. These transfers can be in cash, in-kind or both. Social protection measure can include conditional and unconditional cash transfers, in-kind household food distributions, and school feeding programmes (Ruel 2013).

2.8.1 Evidence of social protection interventions on female education

Targeted social protection measures have a demonstrated success in closing the gender gap in education in terms of enrolment and attendance, especially in countries with wide differences between girls and boys (Filmer et al. 2008; Behrman et al. 2009; Fiszbein et al. 2009; Baird et al. 2011). In Bangladesh for example, every year of exposure to the Female Secondary School Assistance Program, targeted to girls aged 11-18 years, increased the female enrolment rate by 12 percentage points (Khandker et al. 2003). Likewise, the Punjab Education Sector Reform Program of Pakistan increased enrolment of girls aged 10-14 years by 9-11 percentage points (Chaudhury et al. 2010). In Cambodia a similar programme for grades 7-9, which supports girls in the transition from elementary to secondary school, increased girls' enrolment by 30 percentage points (Filmer et al. 2008). In Malawi, the Zomba's Conditional Cash Transfer has shown an increase of 8 percentage points in overall school attendance among 13–22-year single females (Baird et al. 2011).

Evidence suggests that conditionality of cash transfers is critical for achieving enrolment and attendance outcomes among girls aged ten years and above. Different researchers have pointed out that the impact of unconditional cash transfers (UCT) is only a fraction of the impact of the conditional cash transfers. For example, the effect of the increase in schooling of unconditional transfers is only 20% (Todd et al. 2006) and 43% (Baird et al. 2011) of the impact of conditional transfers in Mexico and Malawi, respectively.

School feeding programmes have showed some impact in enrolment and attendance of girls (Powell et al. 1998; Simeon 1998; Greenhalgh et al. 2007; Alderman et al. 2008; Alderman et al. 2012). In Uganda, an experimental World Food Program's take-home rations programme for grades 6-7 was very effective in increasing girl's morning attendance by 30 percentage points

(Alderman et al. 2008). However, this programme also created a strong incentive for hungry children to stay in grades 6-7 and delay secondary school (Alderman et al. 2008).

Coady and Parker (2004) compared the cost-effectiveness on girls' school attendance of demand-oriented conditional cash transfers with supply-oriented infrastructure projects. Although a reduction in 1 km in the distance to the nearest secondary school from a mean of 2 km results in an increase of 8.6 percentage points in girl's attendance, the construction cost exceeds by far the cost of providing conditional cash transfers.

2.8.2 Evidence of social protection interventions on women's reproductive practices

The ability of women to exercise their reproductive rights is associated to their level of education and to their influence in household decision-making. Cash or in-kind payments directly provided to women can enhance their access to reproductive health (Westoff 1988; Al Riyami et al. 2004; Ahmed et al. 2010; Baird et al. 2010).

There are synergies between health programmes and social protection programs in the provision of family planning. For example, conditional cash transfers in the Mexican PROGRESSA program require attendance to family planning lectures and counselling sessions (Gertler 2004). Evidence from a wide range of countries suggests that conditional cash transfers have been effective in increasing the attendance to health lectures and the use of women's reproductive health services (Lagarde et al. 2007; Gertler 2004).

A number of hypotheses can be advanced on how conditional cash transfers can influence contraceptive use. First, cash or in-kind transfers empower women through equalizing women's access to and control over economic resources (Kabeer 2009). Accordingly, logistic regression models and meta-analysis techniques have shown that empowered women are up to two times more likely to use modern contraception than those with null empowerment scores (Ahmed et al. 2010). Second, the demonstrated success of conditional cash transfers in reducing the gender gap in education, can have a sizeable impact in family planning demand. For example, women with complete primary education are two times more likely to use modern contraception than those less educated (Ahmed et al. 2010). Similarly, several researchers have found a negative association between un-met needs for family planning and years of schooling (Westoff 1988, Al Riyami et al. 2004). In Kenya, women with less than secondary education were two times more likely to experience unmet need for family planning than those with higher levels (Wafula et al. 2007).

In India, the introduction of conditional cash transfers for accepting any temporary contraceptive method resulted in an increase of contraceptive use only when the economic incentive was accompanied by the active engagement of village-trained women as peer counsellors and suppliers (Stevens et al. 1992; Sunil et al. 1999). Women who received this intervention had three times higher odds of using temporary contraceptive methods compared with their counterparts in the control group that only received the cash transfers (Sunil, Pillai et al. 1999).

In Malawi, the Zomba Cash Transfer Program (ZCTP) led to a remarkable decline in early marriage and teenage pregnancy among its beneficiaries (Baird et al. 2010). For women who were out of school before being enrolled in the program, the likelihood of getting married or becoming pregnant dropped by more than 40 and 30%, respectively (Baird et al. 2010).

Conditional cash transfers, however, have shown limited impacts on birth spacing and fertility (Feldman et al. 2009; Stecklov et al. 2006; Fiszbein et al. 2009). An evaluation study on the Honduran Conditional Cash Transfer, Programa de Asignación Familiar (PRAF), showed that the programme design created the unintended strong incentives for increasing childbearing and resulted in an increase in fertility of 2 to 4 percentage points among its beneficiaries (Stecklov et al. 2006).

2.8.3 Evidence of social protection intervention on maternal, infant and young child feeding practices

In Africa, Asia and Latin America, cash transfers have been shown to improve both the quantity and the diversity of food consumption, and to protect food consumption during shocks or lean periods (World Social Protection Report 2014/15; Save the Children 2012). Rural households on Brazil's Bolsa Familia scheme were found to spend as much as 88% of the cash received on food (Save the Children 2012).

A large body of evidence supports the hypothesis that women have different preferences over household consumption than do men (Thomas 1990; Hoddinott et al. 1995; Ward-Batts 2008; Leroy et al. 2009). Different studies have shown that households where women receive the cash transfers spend a larger proportion on food (Schady and Rosero 2008; Fiszbein et al. 2009). Conditional cash transfers increased daily per capita caloric consumption by 12% in Brazil, 6% in Colombia and 38% in Nicaragua (Fiszbein et al. 2009). Similarly, conditional cash transfers affect caloric diversity by increasing animal protein, fruits and vegetables and, in some cases, reducing consumption on staples (Angelucci and Attanasio 2009; Fiszbein et al. 2009; Leroy et al. 2009). The increase in food expenditure in Colombia was largely driven by increased consumption of protein (milk, meat and eggs) while in Nicaragua and Mexico it was driven by increased consumption of meat, fruit and vegetables (Fiszbein et al. 2009). While this evidence shows improvement in household food quantity and diversity, there are no studies that have specifically looked at the impact on maternal and/or child diet.

Maternity protection is vital to optimize infant and young child feeding. Exclusive breastfeeding in particular requires that a woman be in close proximity to her baby so that she is able to breastfeed on demand. The ILO Convention C183 and recommendation R191 cover seven key elements of maternity protection: scope, leave, benefits, health protection, job protection and non-discrimination, breastfeeding breaks and breastfeeding facilities. The 2012 World Breastfeeding Trend Initiative (WBTi) report that, of the 51 analysed countries, only eight countries offer women in the unorganized and informal sector the same level of maternity protection as the formal sector. The inclusion of maternity protection in the implementation of

social protection programmes is critical for two reasons. First, the great majority of female beneficiaries are employed in the unorganized and informal sector of the economy. Second, women do often participate in the social safety-nets employment schemes and are at risk of being subject to heavy and hazardous work during their pregnancy and while breastfeeding.

Most of the conditional cash transfers require a minimum attendance to health check-ups and health related lectures at the frontline services, which may influence women's behaviour and improve their infant and young child feeding practices. While there are no specific studies that have looked into how conditional cash transfers can influence the uptake of adequate complementary feeding practices, a number of hypotheses can be advanced. First, through regular visits to frontline services and health lectures, women can learn what foods they need to complement to their children's diet in the critical time between 6 and 23 months when breast milk is no longer enough to meet their nutritional needs. Second, it is demonstrated that women with control over household resources invest more in their children's diet (Smith et al. 2003, van den Bold et al. 2013). Third, most of cash or in-kind transfers do or have the potential to include fortified foods and multiple micronutrient supplements with the specific aim of improving the nutritional status of mothers and children (Bassett 2008). The distribution of these products among beneficiary households seems to be critical in stunting and underweight reduction (Bassett 2008; Leroy et al. 2009). A study of the Mexican PROGRESSA program showed that children under five years of age that consumed fortified products had significantly greater intakes of iron, zinc and vitamin A than their peers in the control group. These results were significant despite the low rates of utilization of these products among beneficiary households. A specific analysis on the sub-group of children aged between 6 and 23 months showed that only 57% consumed the fortified products four or more times a week. There were various reasons for this suboptimal utilization such as mother's misconceptions about the product and lack of knowledge on how to use it correctly (Leroy et al. 2009).

2.9 Governance of nutrition: challenges for multisectoral approaches

The Lancet series in 2008 and 2013 provide a strong case for an approach that goes beyond health and requires coordinated efforts by key sectors to address both the immediate and underlying determinants of child stunting. The 2013 Lancet series, defines nutrition-sensitive interventions when these address the underlying determinants of foetal and child stunting and have clearly stated nutrition outcomes and actions. The authors also identify the potential for nutrition-sensitive interventions to serve as delivery platforms for high-impact nutrition interventions, potentially increasing their scale, coverage, and effectiveness. While interventions themselves might be single sector in nature, the authors point to the importance of looking at their convergence on population groups that are most vulnerable to child stunting. A key element in the governance of nutrition is the articulation of the immediate and underlying determinants of child stunting across sectors to help each sector understand how their contribution will have an effect on nutrition outcomes and actions.

A review of the past forty years reveals the comings and goings of the 'multi-sectoral' approach in nutrition (Mokoro 2015). In 1970s, the recognition of under-nutrition as a development problem, instead of a medical condition, created, for the first time, a commitment to multi-sectoral, multi-partner, and multi-level collaboration. Despite the publicized commitments, many of the first generation nutrition plans never got off the ground. Both Field (1987) and Berg (1987) explained this failure with what they perceived as a top-down technocratic approach for planning that did not take into account the implementation reality. Whilst Field made a case for selected intra-sectoral interventions to be operationalized using a bottom-up approach, Berg argued about keeping a comprehensive multi-sectoral analysis but leaving all decisions on implementation to each sector.

In 1992, during the first International Conference on Nutrition (ICN1), global leaders adopted The World Declaration on Nutrition and a related Plan of Action for Nutrition. Governments committed to develop national multi-sectoral plans by the end of 1994 and the international community committed to align resources behind them. Regional review meetings held in 1996, 1999 and 2001, identified major constraints to the actual implementation of the national plans. The failure was explained by a mismatch between the level of ambition and the lack of political support, resources and capacity. In the early 2000s, the focus narrowed down to the implementation of specific nutrition interventions with demonstrated impact: micronutrient interventions gained the limelight (Mokoro 2015).

In a more recent contribution, Garrett et al. (2011) argue that the political economy is now more conducive for a multi-sectoral approach, mostly thanks to an unprecedented high-level political support for nutrition. At the same time, given the past failure of multi-sectoral plans, there is an expectation for key stakeholders, from Government ministries and development partners, to align their actions towards the achievement of nutrition outcomes that can show the impact of the investments (World Bank 2013; Mokoro 2015). Whilst stakeholders will be accountable for the interventions they have committed to deliver, the impact on child stunting of their interventions will be also influenced by what others are doing in terms of timing, targeting, implementing, monitoring and evaluating their own interventions. The achievement of a collective impact on child stunting, requires a combination of different modalities of working together. These modalities can range from networking, or simply exchanging information, to co-ordination, where partners co-operate towards shared goals, to collaboration, where partners share resources or personnel, to integration, where partners share managerial responsibilities (Harris et al. 2012). The fundamental requisite for addressing child stunting, however, is that policies, programs, resources and actions bear at the same time and place on the same child (Garrett et al. 2011; Levinson et al. 2013).

Mejia Acosta et al. (2012 and 2014), note that whilst the policy makers and experts in nutrition know what must be done and, to a less degree, how to do it, the political dynamics significantly limit their collective ability to co-determine nutrition outcomes. Similarly, a joint-assessment exercise conducted in 37 countries by Government and non-government stakeholders indicates

the lowest collective scores on the implementation capacity for improved nutrition outcomes (SUN Movement Progress Report 2014). Among the given reasons, many criticize the lack of clarity on the decisions that were made during the planning phase, which in turn limits the consensus on what each stakeholder should be held accountable for. Most national plans developed in the timeframe 2010-2015 are criticized for reflecting the interests of the main sector that took the lead in drafting. The development of the nutrition plans was often led by the health sector with little engagement of other sectors and limited understanding on their institutional mandate in terms of roles and responsibilities.

There are several reasons why multi-sectoral implementation for nutrition is disappointing. First and foremost, there is little demand for nutrition by the political constituency due to the invisibility of the problem. Nutrition might be in the political agenda because politicians choose to put it there, not because they are forced to address it by their own constituency. Second, improved nutrition outcomes requires inputs from several sectors, which in turn are often unclear on how the benefits will outweigh the costs of working together. The way in which Government resources are budgeted for, spent and reported on does not incentivise agencies to collaborate together (Mokoro 2015).

The establishment of an agreed set of results towards the common goal of child stunting reduction may be a better way to provide incentives for multiple sectors to work together than developing a single plan. Collaborative agreements across sectors require transparency, inclusion and ownership in defining the results and the related interventions for which different actors are held to account. The included interventions should reflect what is feasible, given actual and forecasted resources. Accountability mechanisms can provide incentives for results if the indicators that are going to be monitored, in terms of implementation and spending, reflect the impact pathway towards child stunting reduction.

Chapter 3: The research method applied to the Yemen case

3.1 Evidence and gaps emerged from the literature review and secondary data analysis

Child stunting is a measure of nutrition status and an established risk factor not only for mortality but also for poor child development. The literature review in Chapter 2 identified three immediate determinants of child stunting: birth outcomes, complementary feeding practices for children between 6 and 23 months and incidence of diarrhoea and exposure to environmental enteric dysfunction among young children. There was an established evidence-based literature body of nutrition-specific interventions that address child stunting and are primarily delivered through the health sector.

A similar literature body of compiled and tested evidence-based recommendations was not found for nutrition-sensitive interventions. The literature review in Chapter 2 compiled the current evidence on the role of each sector in the delivery of interventions with the potential to affect the prevalence of child stunting. This literature review helped to identify the links between child stunting, its most significant immediate and underlying determinants and the contribution each sector could bring through their own public investments.

The literature review showed the extent to which public health-based investments directly affect immediate determinants of under-five child stunting such as birth outcomes, infant and young child feeding practices and diarrhoea incidence. Health based facilities and outreach services ranged from nutrition counselling to the provision of fortified food supplements, the promotion of hygiene practices and the use of sanitation facilities and treatment of drinking water at point of use. Chapter 2 presented the results from published meta-analyses about the effects of a variety of public health interventions on the uptake of exclusive breastfeeding for children under six months and on contraceptive use among women of reproductive age. However, the literature review in Chapter 2 identified a major gap of comparable studies about the effect of public health interventions on the uptake of appropriate complementary feeding practices for children aged 6-23 months. This was due to the variety of outcome variables used in the identified studies as opposed to the two WHO recommended indicators, which are Minimum Appropriate Diet (MAD) and Minimum Dietary Diversity (MDD).

The literature review in Chapter 2 revealed significant limitations with the publications that explore the effect of agriculture interventions on nutrition outcomes. First, the identified studies only focused on the consumption uptake of specific food items promoted by the researched interventions without considering the impact on the overall diet, especially among pregnant and lactating women and young children. Second, the studied agriculture interventions were often narrow in scale and scope. Many of the studies focused on the promotion of home-gardens, which are rarely considered by decision-makers in their portfolio of public agriculture investments. Third, there was no literature on the impact on people's diet

of conventional large-scale public agriculture investments such as farmer's subsidies, agriculture extension services or access to credit. Because of these three major limitations, Chapter 2 introduced a methodology developed by Remans et al. (2014), which was based on the use of regression analysis to identify significant associations between a select set of nutrition and agriculture variables. Agriculture variables were measured against intermediary determinants of child stunting which remains the ultimate impact indicator. For child nutrition, Remans et al. (2014) used minimum acceptable diet among children aged 6-23 months and three proxy indicators for maternal diet. These three proxies together represented what should constitute an essentially balanced adult diet: calories per capita, percentage of energy from non-staples and iron availability from animal products.

The limitations of the current literature, suggest the need for decision-makers in the field of nutrition to look at other methods beyond the use of randomized controlled trials (RCTs) as the only legitimate source of evidence (Pinstrup Anderson 2013). The literature review in Chapter 2 showed that the impact pathway between sectoral investments and under-five child stunting is complex and needs to be broken down into measurable associations. For example, when assessing how to increase the uptake of the minimum acceptable diet among children aged 6-23 months, different sectoral measures are needed in the analysis. On the supply side, investments in agriculture and trade have an immediate effect on the availability and affordability of nutritious and safe foods. The social protection sector is called upon to ensure that children from poor households have equal access to nutritious and safe foods. On the demand side, the health sector is mandated to adequately inform the public, in particular mothers and caregivers, on the optimal use of nutritious and safe foods based on the child nutritional requirements. The minimum acceptable diet, however, is not the only determinant of child stunting. The incidence of diarrhoea and the exposure to the environmental enteric dysfunction limit a child's capacity to adequately absorb the nutrients contained in the foods. Additional sectoral measures to reduce child stunting prevalence would therefore entail adequate access to quality drinking water and living in an appropriate sanitary setting.

If RCT designs are insufficient for studying such complex, interrelated phenomena then consideration needs to be given to alternative designs. This research will look at the application of a method that helps decision-makers to systematically assess what mix of sectoral interventions are most likely to have direct and indirect impacts on child stunting taking into account specific contextual factors. Such a method incorporates quantitative analysis and explores the relevance of the findings with key decision-makers.

3.2 Research hypothesis and objectives

The conceptual framework (Figure 1) described under Section 2.2 shows the importance of engaging other sectors beyond health in order to address the immediate and underlying determinants of foetal and child nutrition. The literature review in Chapter 2 focuses on child

stunting and presents the available evidence on public interventions promoted by key sectors such as agriculture, social protection, education and WASH.

Based on the literature review, the first hypothesis is that decisions for the ‘mix’ of interventions to reduce the prevalence of child stunting are not the sole responsibility of the health sector but require the full engagement of the other key sectors. As described under Section 2.9, the full engagement of relevant ministries, departments and agencies is enabled if there is the highest-level political commitment towards multi-sectoral approaches for enhanced nutrition outcomes.

A closely related second hypothesis is that the relative contribution by each sector will depend on the specific context and will vary according to the incidence of key determinants associated with child stunting prevalence. Selectivity is needed. For example, the relative contribution of the WASH sector will be predominant in areas with high density of population coupled with high prevalence of open defecation but not in areas that have reached sustainable drinking water supply and sanitation coverage. In the latter case, behaviour change might be needed to increase use and the maintenance of the existing infrastructures. Changes in behaviours might be better addressed through communication strategies that use multiple contact points rather than solely through WASH investments.

The research addresses the question **“what mix of public interventions works best in a given context to reduce child stunting prevalence”**. One country, Yemen, will be used as a case study. In order to answer the question the research will first identify the determinants of child stunting, particularly those that are relevant from a policy perspective. The findings from the quantitative analysis will be discussed with decision-makers from key sectors to assess the extent to which they are useful in informing policy and programmatic choices. While the case study refers to only one country, the aim of the research is to define a method that can be used in any given context to help decision-makers assessing the potential impact of multi-sectoral approaches on child stunting reduction.

The criteria for the selection of the country included: 1) Availability of data and studies to conduct the analysis in order to identify the suggested mix of public interventions, 2) Opportunity to engage with decision-makers at the highest level to assess how the findings from the analysis were used to inform decisions on the selected mix of public interventions and 3) Political commitment to apply a multi-sectoral approach to reduce the prevalence of child stunting. Yemen was chosen as the country case study because the Minister of Planning and International Cooperation made an official request for technical assistance to support their planning and financing cycle for nutrition. This request was made in September 2013 and the research author led a multi-disciplinary team to assist the Government of Yemen during 2014 and in the beginning of 2015. In light of the current conflict, the support has been changed towards the provision of an emergency nutrition response.

The research objectives are:

- **Objective 1: Conduct a descriptive analysis to identify the mix of public interventions to reduce child stunting prevalence in the context of Yemen.** Key determinants, risk factors, practices and interventions identified in Chapter 2 are organized into a conceptual framework that is used as the starting point for the descriptive analysis. Based on available population-based survey data, the aim is to select a set of dependent and independent variables that are linked to current public interventions in Yemen and/or are plausible from a policy perspective.
- **Objective 2: Conduct a quantitative analysis to understand if the identified mix of public interventions to reduce child stunting is relevant to the context of Yemen.** Regression analyses will be used to identify statistically significant associations (or not) between the selected dependent and independent variables after controlling for confounding variables. This will help to define the mix of public interventions that will be discussed with decision-makers.
- **Objective 3: Discuss the findings of the analyses with public sector decision-makers in Yemen.** The ultimate aim is to assess the usefulness of the method in informing decisions on what mix of public interventions works best in the context of Yemen to reduce child stunting prevalence. This part of the research will be conducted using a qualitative approach to discuss the analytical findings with key Government decision-makers and representatives from non-government organizations and development partners. It will be based on one participatory consultation in the form of a workshop and on individual feedbacks. The aim is to highlight the political and institutional arrangements and the cultural and financial considerations that ultimately influence policy decisions.

3.3 First research objective: Identifying the mix of public interventions through a descriptive analysis

There is growing scientific evidence that, to prevent stunting, a child must receive food with adequate energy, protein and micronutrients while at the same time having access to appropriate parental practices, safe drinking water, good sanitary conditions and quality health care (Garrett et al. 2011, Bhutta et al. 2013). The reduction of child stunting prevalence requires actions from key sectors, at a minimum public health, agriculture, education, social protection and WASH.

The descriptive analysis aims to answer the following sub-questions:

1. What is the current prevalence and trend of child stunting? What other types of maternal and child malnutrition are predominant in Yemen?
2. What is the current prevalence and historical trend of the immediate determinants, risk factors and practices linked to child stunting?

3. What are the public interventions that address the immediate determinants, risk factors and practices linked to child stunting?

One of the first challenges of working with sectors beyond health includes the lack of understanding on why a specific sectoral ministry, department or agency should get engaged in addressing child stunting. Achieving a common knowledge on which determinants are significantly associated with child stunting can help to justify the need for a multi-sectoral approach. This is particularly important when decisions need to be taken on the geographic and demographic targeting of sectoral programmes, especially in contexts where service coverage is low and child stunting is high.

A study by Alderman (2013) shows how a clear identification of common ground in the provision of public interventions for nutrition can act as a powerful incentive in building the matrices of roles and accountabilities of key sectors. The decisions on how each sector wants to measure its individual results against a collective impact on child stunting are crucial if the aim is to compare a multi-sectoral approach from a business-as-usual approach. For example, if child stunting is recognized as the collective impact success, there could be a strong economic argument for a multi-sectoral approach instead of a single-sector approach. This is especially the case if the involved stakeholders are able to demonstrate how their own interventions, targeted and implemented into the same disadvantaged households and communities, have been accompanied by an overall reduction in the prevalence of child stunting. The convergence of efforts by different sectors was identified as one of the key success factors to explain the rapid reduction in the prevalence of child stunting in Brazil, Peru and Bangladesh (Levinson et al. 2013). Similarly, leveraging existing interventions for the delivery of specific nutrition actions has been associated to cost savings, resulting in more cost-effective programmes (Chase et al. 2016).

3.3.1 Population-based surveys included in the descriptive analysis

The descriptive analysis aims to identify key pathways towards child stunting by mapping the variables in the population-based surveys, which are relevant for decision-makers in the Yemen context. The descriptive analysis is based on the reports from three large-scale surveys that all together cover the multi-dimensional determinants of child nutrition.

The 2011 Comprehensive Food Security Survey (CFSS) was chosen because it is a multi-dimensional study that includes information on demography, education, water and sanitation, household assets, agriculture and livestock, income and livelihoods, expenditures and debt, food consumptions, sources of food, coping mechanisms, household exposure to shocks, nutrition, infant and young child feeding practices, access to markets, health facilities and schools, market availability, market prices, impact of shock to markets and recovery. The main source of information for the CFSS analysis was from primary data collected through three questionnaires: a household questionnaire, a questionnaire for women of reproductive age (15-49 years) living in the household and a questionnaire for children under five years of age, which

also included the collection of anthropometric measurements. Focus group discussions were conducted in all the visited communities while trader surveys were implemented in important markets across the country. In total 7,750 households were interviewed. More than 10,000 women were interviewed and more than 11,000 children were measured for weight, height and MUAC. In addition, over 170 markets were visited.

This 2013 UNICEF Knowledge Attitude and Practice (KAP) baseline survey was chosen because of its comprehensive overview of knowledge, attitude and practices that are relevant to child development, health and nutritional outcomes. The UNICEF KAP baseline survey only targeted vulnerable districts in Yemen with a total of 106 out of 333 districts. Results are therefore not representative of the national population. The survey provides information on demographics, education (adult population, child, and school facilities), fertility and maternal health, child nutrition and health status, infant and young child feeding practices, child protection including child labour, early marriage, polygamy, water supply, sanitation and hand washing. Focus group discussions were conducted in all the visited communities. Three questionnaires were used in the UNICEF Baseline Survey: a household questionnaire, a questionnaire for women of reproductive age (15-49 years) living in the household and a questionnaire for children under five years of age, which also included the collection of anthropometric measurements (height, weight and middle upper arm circumference). The child questionnaire included a module on breast-feeding and complementary feeding practices for children 6-23 months. The final sample comprised 3,544 households, 5,453 women and 3,801 children.

The 2013 Yemen National Health Demographic Survey (YNDHS) was chosen because of its comprehensive overview of basic demographic and health indicators that include information on: marriage, fertility and fertility preference, knowledge and use of family planning methods, infant and young child feeding practices, nutritional status of women and children, maternal and childhood mortality, awareness and attitudes regarding HIV/AIDS, female genital cutting, and domestic violence. The final sample comprised 17,351 households, 17,318 married women and 9,488 never-married women. Three questionnaires were used in the 2013 YNHDS: a household questionnaire and two individual questionnaires (one for married women and an abbreviated version for never-married women). A specific module on food security was added to the original set of questions.

Details on the sampling methodology and on the data processing are described in Annex 2.

3.3.2 Variables identified for the descriptive analysis

3.3.2.1 Indicators for child nutritional status

The descriptive analysis starts with an understanding of the child nutritional status in Yemen. As recommended by the World Health Organization (WHO), the measurement of child nutritional status is based on the comparison of anthropometric indicators for children under age five years with indices reported for a reference population of well-nourished children. The indices are expressed as standard deviation (SD) units from the median of the WHO Child Growth Standards adopted in 2006. Children who fall below minus two standard deviations (-2 SD) from the median of the reference population are regarded as moderately malnourished, while those who fall below minus three standard deviations (-3 SD) from the median of the reference population are considered severely malnourished.

Height-for-age is the measure of linear growth. A child who is below minus two standard deviations from the reference mean for height-for-age is considered short for his/her age, or stunted, a condition reflecting the cumulative effect of chronic malnutrition. The prevalence of stunted children is the primary dependent variable of this research.

Weight-for-height describes current nutritional status. A child who is below minus two standard deviations from the reference mean for weight-for-height is considered too thin for his/her height, or wasted, a condition reflecting acute or recent nutritional deficit. The prevalence of wasted children is the secondary dependent variable of this research because of the bi-directional relationship with stunting.

3.3.2.2 Immediate determinants of child stunting

The immediate determinants identified in Section 2.2 of Chapter 2 are:

- Birth outcomes (small-for-gestational age and preterm);
- Complementary feeding practices for children 6-23 months;
- Incidence of diarrhoea and exposure to environmental enteric dysfunction.

Black et al (2013) use small-for gestational age (SGA) and pre-term to model the effect of birth outcome on stunting but the data are not available for most countries. Low-birth weight is used as a proxy for birth outcome and is defined by the World Health Organization (WHO) as weight at birth less than 2500 grams.

The descriptive analysis aims to look into infant and young child feeding practices with a focus on appropriate complementary feeding of children aged 6-23 months given its role in preventing a child to become stunted (Bhutta et al. 2013). Exclusive breastfeeding for the first six months and continued breastfeeding up to two years are indicators of optimal breastfeeding, which has evidence on reduced morbidity but not on stunting (Black et al 2013).

The descriptive analysis will also look into the prevalence of diarrhoea incidence among children under five years of age and into information on the environmental enteric dysfunction,

which is an acquired disorder occurring in young children living in unsanitary settings (Humphrey JH 2009).

3.3.2.3 Risk factors, practices and public interventions associated to child stunting

The nutritional status of women in reproductive age (15-49 years) is closely linked to birth outcomes. A number of standard indicators are defined by the World Health Organization (WHO) to measure the women nutritional status. These include prevalence of thinness (BMI <18.5) overweight (BMI \geq 25 and <30) and obesity (BMI \geq 30). Maternal obesity is a risk factor for complications during pregnancy, delivery and post-partum. Children born to obese mothers are at higher risk of becoming overweight in childhood, adolescence and early adulthood (Black et al. 2013). The height of the mother is an important predictor of low-birth weight and under-five child stunting (Black et al. 2013). The descriptive analysis will explore risk factors, practices and public interventions linked to three key sectors: health, agriculture and WASH. Women's empowerment is looked throughout the analysis by taking into account gender disaggregated data related with education, household characteristics and exposure to shocks.

Within the health sector, fertility rate and trends are examined as a proxy for maternal age, parity and spacing, which are all risk factors associated with birth outcomes. Relevant interventions in the health sector span from pre-conception until the child is two years old. The descriptive analysis will aim to look into the current coverage and historical trends of key health-based nutrition-specific interventions as identified in the global literature review and cross-country secondary-data analysis. Within the agriculture sector the descriptive analysis aims to explore key variables at household and community level, mostly derived from the 2011 Comprehensive Food Security Survey. Within the WASH sector variables of interest will be those that explore access to improved water and sanitation facilities as well as on specific hygiene variables such as hand-washing facilities and treatment of drinking water at point of use.

3.4 Second research objective: Assessing the relevance of the mix of public interventions through a quantitative analysis

The prevalence of child stunting is the result of many factors with multiple relationships rather than a single causal relationship, as extensively presented in Chapter 2.

The aim of the quantitative analysis is to identify statistically significant associations (or not) between the selected dependent variable (child stunting) and independent variables after controlling for confounding variables.

The quantitative analysis will complement the descriptive analysis (Objective 1) and validate some of its key findings in order to help with defining the mix of public interventions that will be discussed by decision-makers (Objective 3). The quantitative analysis will answer the following questions:

1. What are the key variables significantly associated with the outcome of a child being stunted in Yemen?
2. What are the key variables significantly associated with the outcome of diet diversity among children aged 6-23 months in Yemen?

There is a recognized risk that by looking at multiple variables, the interpretation of the findings might be diluted. However, this risk will be minimized by, first, using the findings from the descriptive analysis to provide the context (Objective 1) and, second, by discussing the main findings with decision-makers in order to get their policy perspective (Objective 3). Therefore, the quantitative analysis should not be seen as a stand-alone piece.

3.4.1 The dataset used for the quantitative analysis

The most commonly used data source for the quantitative analysis in low and middle-income countries is the Demographic Health Survey (DHS). In terms of spatial coverage the DHSs are nationally representative, although in some cases, geographic areas might be excluded due to security and logistical issues. Data are comparable over time, which allows for trend analysis. Moreover the DHSs are representative at rural and urban level and also at sub-national level through the use of complex design. The sample and the indicators allow performing the analysis at the level of the child and of the household. At the time of this research, the dataset from the 2013 Yemen National Health and Demographic Survey (YNHDS) is not publicly available. For this reason findings from the 2013 YNHDS are only presented in the descriptive analysis (Objective 1).

The main dataset for this research is the 2011 Comprehensive Food Security Survey (CFSS) collected by the Central Statistical Agencies along with the World Food Program and funded by a wide range of donors. The sampling frame is designed to provide representative statistics at national, sub-national, agro-ecological and urban/rural levels. The sample and the level of indicators allow performing the analysis at the level of the child and of the household.

An additional dataset is the 2013 UNICEF baseline survey on Knowledge, Attitude and Practices, administered in 106 out of 333 districts in a sub-set of 10 out of 19 governorates⁷. The dataset covers all the indicators that are relevant for maternal and child health and nutrition.

At the time of this research, there are no comparable datasets from two rounds of surveys (e.g. CFSS or YNHDS). This would have enabled to statistically analyze trends in order to understand which variables can be associated with changes over time.

3.4.2 Outline of the quantitative analysis

The analysis will include the following four steps:

Steps	Justification
1. Selecting and prepping the variables	<p>This step builds on Chapter 2 and on the findings from the descriptive analysis (Objective 1).</p> <p>This step aims to select the variables that will be included in the regressions. Variables that pertain to the same domain will be dropped.</p>
2. Conducting the regressions	<p>Different statistical methods will be used in order to find the best regression model.</p> <p><i>Child stunting</i> and <i>child wasting</i> will be used as the outcome dependent variables to identify variables associated with under nutrition.</p> <p>An additional analysis will be run using <i>child diet diversity</i> as the outcome dependent variable (number of food items and animal-protein source of foods).</p>
3. Interpreting results from the regressions	Different types of robustness checks will be performed to ensure that the model provides a good fit of the data.
4. Conducting simple simulations	Regression equations will be used to predict outcomes to inform decision-makers.

⁷ The UNICEF baseline survey was administered in 106 UNICEF targeted districts primarily located in Al Jawf, Amran, Baida, Dhale, Dhamar, Hajja, Ibb, Rayma, Sana'a and Tihama.

3.4.2.1 Selecting and prepping the variables

The quantitative analysis looks at the child height-for-age z-scores (HAZ) as the measure of linear growth against WHO (2006) norms. The identification of the variables is based on the three CFSS questionnaires: the household questionnaire, the questionnaire for women of reproductive age (15-49 years) living in the household and the questionnaire for children under five years of age living in the household.

The review of the questions immediately shows which variables of interest are *not* available in the CFSS dataset. These include: low-birth weight prevalence, breastfeeding practices like early initiation, household hand-washing practices, household safe disposal of child faeces, access to family planning services, access to ante-natal care (ANC), delivery by a skilled provider, delivery in a health facility, promotion of exclusive breastfeeding in health facilities or hospitals, promotion of infant and young child feeding (IYCF) practices, treatment of child diarrhoea. For this reason, separate regressions are run using data from the 2013 UNICEF baseline survey, which provides more comprehensive data on maternal and child health care including access to drinking water supply, improved sanitation and hygiene.

3.4.2.2 Conducting the regressions

The regressions will be run using STATA version 14.0. Regression analysis involves estimating an equation that best describes the data. One variable is considered the dependent variable, while the others are considered the independent variables. STATA is capable of many types of regression analysis and statistical tests.

Nutrition outcomes can be modelled by taking their values as standardised z-scores, both for height-for-age and weight-for-height, and therefore be estimated with Ordinary Least Squares (OLS). Otherwise, the prevalence of stunted children and the prevalence of wasted children can be modelled by transforming the z-scores into binary variables for defining whether a child is stunted (or wasted).

For the regression, two types of model might be considered: Ordinary Least Square and Probit. The OLS is used when the dependent variable is a continuous variable. The Probit model is used when the dependent variable is a binary variable capturing whether or not a child is stunted. In light of the dichotomous nature of the variables, the Probit model offers an immediate interpretation of the results, which is especially useful for a decision maker, who is not familiar with statistics.

The Poisson model applies for a count variable (e.g. number of foods accessed by a child aged 6-23 months).

There are different statistical methods for finding the best regression model. First, different types of specifications can be foreseen to explain child stunting and child wasting. Alternatively the practice of 'reducing the model' could be applied by including all candidate predictors in the

model, and then systematically removing the term with the highest p-value one-by-one until the model only includes significant predictors.

3.4.2.3 Interpreting the results

When running a regression, the aim is to discover whether the coefficients on the independent variables are really different from 0 or if alternatively any apparent differences from 0 are just due to random chance. The null hypothesis is always that each independent variable is having absolutely no effect (has a coefficient of 0).

The Standard Error can tell how wrong the regression model is on average using the units of the response variable. Smaller values indicate that the observations are closer to the fitted line. The Standard Error can help to understand how close the predicted values are to the observed values. The size of the Coefficient for each independent variable gives the size of the effect that the independent variable is having on the dependent variable, and the sign on the coefficient (positive or negative) gives the direction of the effect. In regressions with multiple independent variables, the coefficient will tell how much the dependent variable is expected to increase when that independent variable increases by one, holding all the other independent variables constant. The P-value tells how confident one can be that each individual variable has some correlation with the dependent variable, which is the important thing.

The Probit model does not have an equivalent to the R-squared that is found in OLS regression, which provides an estimate of the strength of the relationship between the model and the dependent variable. In the McFadden's pseudo R-squared the log likelihood of the intercept model (without variables) is treated as a total sum of squares, and the log likelihood of the full model (with variables) is treated as the sum of squared errors. The ratio of the likelihoods suggests the level of improvement over the intercept model offered by the full model. A likelihood falls between 0 and 1, so the log of a likelihood is less than or equal to zero. A small ratio of log likelihoods indicates that the full model is a far better fit than the intercept model. In McFadden's words, pseudo R-squared values from 0.2-0.4 would indicate an excellent model fit (McFadden 1974).

The Poisson model uses the Adjusted R-squared to evaluate the explanatory power and prevent from overfitting the model by assessing whether the correct number of variables has been included. The Pearson goodness-of-fit can be used to test if the Poisson model fits the data. If the test is statistically significant, it would indicate that the data do not fit the model well.

3.4.2.4 Conducting simple predictive simulations

Chapter 2, section 2.4, refers to the Lives Saved Tool (LiST) developed at Johns Hopkins University. LiST is a module that is integrated within the Spectrum v5.07 software programme. This module is based on The Lancet's "Child Survival, Neonatal Survival and Under-nutrition" series (Jones et al. 2003, Darmstadt et al. 2005; Boschi-Pinto et al. 2010; Lawn et al. 2006). The effectiveness values for the selected interventions are derived from a standardised review

process developed by the Child Health Epidemiology Reference Group (CHERG) with United Nations partners. This process determines which interventions should be included using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria (Walker et al. 2010).

Consequently, LiST contains only interventions for which evidence exists of their influence on child stunting as presented in Chapter 2 of this document. For the health sector, the following interventions are included in the simulation: multiple micronutrient supplementation and iron folate supplementation for pregnant women (Haider et al. 2011), Vitamin A supplementation for children (Imdad et al. 2011), management of severe acute malnutrition (Lenters et al. 2013), management of moderate acute malnutrition (Lenters et al. 2013), promotion of breastfeeding practices (Haroon et al. 2013), promotion of complementary feeding practices and provision of complementary food supplements and education for children 6-23 months (Imdad et al. 2011), preventive zinc supplementation for children under five years (Imdad et al. 2011), provision of balanced energy-protein supplementation during pregnancy (Imdad et al. 2011). For the education sector, this includes folic acid supplementation or fortification for adolescent girls (Blencowe et al. 2010). LiST also quantifies the estimated reductions on the prevalence of child stunting that can be expected when each of these interventions is scaled up to target coverage from a given baseline. While the baseline is estimated from data from population surveys or routine systems, the target coverage takes into account the estimated costs for scaling up the interventions according to the available funds and the value for money.

Expanding from LiST, this research will explore additional determinants as identified from the quantitative analysis to see how the stunting prevalence would reduce if the mean values of the selected variables were to change from the current levels. This type of analysis is of particular interest to decision-makers to translate the results from the analysis into programmatic targets.

3.5 Third research objective: Discussing results with public sector decision-makers using an adapted Delphi method

The results need to be analysed within the political economy of the country. This includes providing a perspective of the governance arrangements, the policy and legal framework as well as the financing environment, looking especially at strong and positive trends in government spending that is plausibly linked to improvements in key determinants of child nutrition.

This last part of the study explores the interest of decision-makers and of advisers in the use of the results from the descriptive and quantitative analysis. At a minimum, the information should be able to:

- Demonstrate significant associations between child stunting and key factors.
- Guide prioritization in terms of population targeting and geography.
- Guide the discussion on how current investments can achieve better nutrition outcomes.

- Help with decisions on how to sequence investments looking at the current scale of identified interventions and ways to increase the coverage.

Deciding how best to reduce the prevalence of child stunting can be a controversial process. For example, decision-makers from different sectors and organizations see different priorities for action, depending on their mandate and competency to address specific determinants. Decision-makers have often interests in prioritizing and expanding one type of program rather than another. The consultation should help to assess how findings from the analysis are used across sectors and types of organizations. The quantitative analysis leads to a traditional problem-solving approach where the problems and causes are identified and the potential solutions analyzed and discussed.

The Delphi method can suitably inform a decision making process by using a series of questions that are interspersed with continuous feedback (Dalkey et al. 1963). The controlled interaction is expected to be more conducive to the gradual formation of a considered opinion. A key advantage is that it avoids direct confrontation while keeping participants focused on prioritizing. On the other hand, as emphasized by Kendall et al. (1992), it is important to pay attention to differences of opinion in order to develop a set of alternative scenarios.

The discussion will be organized around three broad questions:

1. What is the context for nutrition?

- Political context
- Cultural context
- Institutional context
- Financial context

2. What are the potential of different options for nutrition?

- Epidemiology (magnitude, risk factors, determinants and practices)
- Potential of different options

3. How are different options prioritized for nutrition?

- Relevance of options to the context
- Estimating requirements in terms of investments (new and existing)
- Balancing options
 - o Decisions on which interventions should be included or excluded
 - o Decisions on how to sequence interventions

Chapter 4: The research analysis for the Yemen case

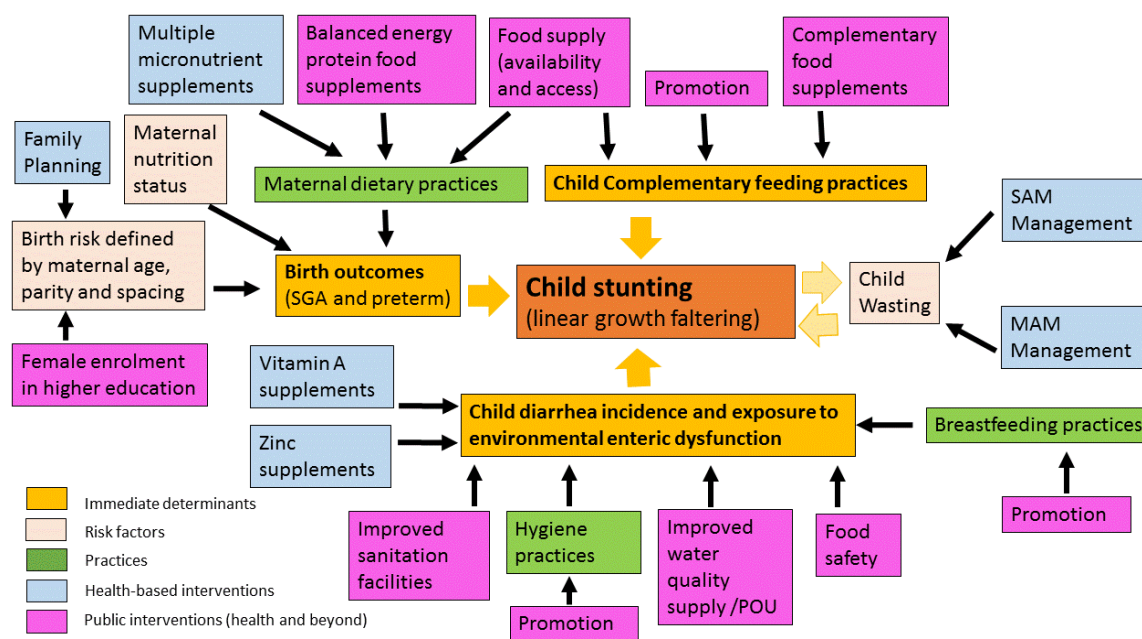
4.1 Adapting the conceptual framework for the analysis

The conceptual framework for the analysis in the context of Yemen built on the Framework for Actions developed in the 2013 Lancet Series on Maternal and Child Nutrition (Figure 1) and on the ten interventions with evidence of highest impact on child stunting (Box 1). The selection of the variables (Figure 6) was based on the literature review and on the analysis of secondary data performed in Chapter 2.

The variables were organized in five groups: 1) Immediate determinants of child stunting; 2) Risk factors affecting the probability of a child becoming stunted either directly or indirectly through the maternal health status; 3) Practices related to feeding, hygiene and dietary intakes that, although influenced by public interventions, are mostly mediated by individual factors like education, beliefs, wealth, etc.; 4) Health-based nutrition interventions that have been shown to impact child stunting and; 5) Public interventions that can be implemented by a variety of sectors (health and beyond) with some evidence of impact on child stunting.

The adapted conceptual framework (Figure 6) did not consider the potential hierarchy between the factors but rather focused on showing how these factors operate to affect the nutritional status of a child.

Figure 6: Adapted conceptual framework on risk factors, practices and public interventions linked to immediate determinants of child stunting



Source: Author; Based on results from Chapter 2

The identified variables in the conceptual framework were then mapped against multiple data sources. The availability of data determined what got included in the descriptive analysis and in the regressions. Whenever possible, proxies were selected for missing variables. In addition, given that the approach was geared towards decision-makers, some variables were added in the analysis at their request.

4.2 First research objective: Conducting the descriptive analysis

4.2.1 Variables included in the descriptive analysis

4.2.1.1 Child nutritional status

Height-for-age and weight-for-height measures were available from the following reports: 2013 Yemen National Health and Demographic Survey, 2011 Comprehensive Food Security Survey and 2013 UNICEF Knowledge, Attitude and Practice Survey. They were disaggregated by child age in months, child sex, child residence and mother's education.

4.2.1.2 Immediate determinants of child stunting

Data on low-birth weight were not available from any of the published reports in Yemen. The only available low-birth weight data in Yemen were from WHO estimates for the period 2000-2008.

With regards to infant and young child feeding practices, variables of interest included optimal breastfeeding practices for children aged 0-23 months, minimum acceptable diet (MAD) and minimum diet diversity (MDD) for children aged 6-23 months. The information was further disaggregated by age in months, sex, residence and mother's education and geographic location.

The descriptive analysis looked into the current prevalence of diarrhoea incidence among children under five years of age with information disaggregated by age group, sex, residence, mother's education and geographic location. Environmental enteric dysfunction was not included in the descriptive analysis as there is no agreed indicator and methodology for data collection on this condition.

4.2.1.3 Risk factors, practices and public interventions associated to child stunting

The only available data on the nutritional status of women of reproductive age in Yemen were from WHO estimates for the period 2000-2008. The Mid-Upper Arm Circumference (MUAC) was used as the proxy to measure the malnutrition status of women of reproductive age by applying the two-cut-off points for severe malnutrition ($\text{MUAC} < 21.3 \text{ cm}$) and moderate malnutrition ($\text{MUAC} \geq 21.3 \text{ cm}$ and $< 22.2 \text{ cm}$). MUAC measures were available in the 2011 Comprehensive Food Security Survey.

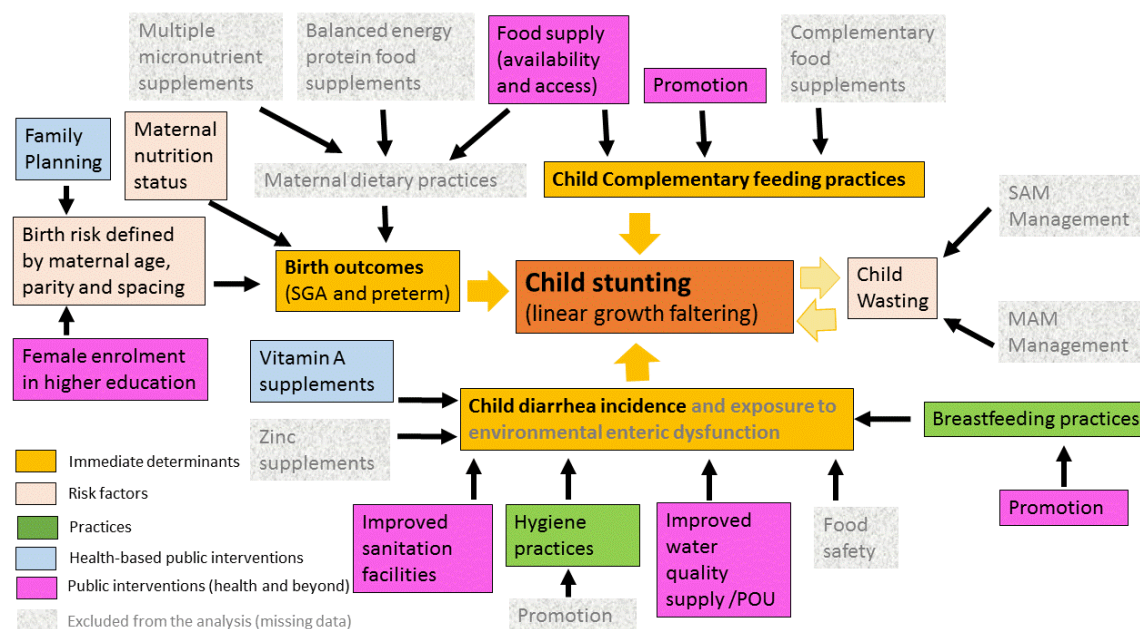
Fertility rate and trends were examined as a proxy for maternal age, parity and spacing. The descriptive analysis looked into the early child bearing phenomenon (births by age 15 and

births by age 18) describing the current prevalence and the historical trend in Yemen. Of the relevant interventions in the health sector, the only variables that could be described included: access to family planning, access to antenatal care and skilled delivery attendants, interventions to promote infant feeding practices for children aged 0-23 months, treatment of diarrhoea for children under the age of five and Vitamin A supplementation for children aged 6-59 months. Four interventions – multiple micronutrient supplementation, zinc supplementation, balanced energy food supplements and complementary food supplements – were not implemented in Yemen by 2014. In addition, there were no published data on the coverage of the management of severe and moderate acute malnutrition. All the above interventions were therefore excluded from the descriptive analysis.

The descriptive analysis included variables for public interventions in the WASH sector related to access to improved water, sanitation facilities, hand-washing facilities and treatment of drinking water at point of use. No information was available on food safety and the promotion of household hygiene.

For the agriculture sector, the research focused on variables of interest at household level that were available from the 2011 Comprehensive Food Security Survey. These included: income and livelihoods, expenditures and debt, food consumption patterns, coping mechanisms and exposure to shocks. The descriptive analysis looked into the Food Consumption Score, which is a composite score based on the dietary diversity, food frequency, and relative nutritional importance of various food groups consumed by a household. As data were not disaggregated by gender, it was not possible to specifically analyse maternal dietary practices.

Figure 7: Applied conceptual framework in the descriptive analysis based on available data



Source: Author

Table 5: Overview of the variables and data sources included in the descriptive analysis (Source 2013 YNHDS; 2011 CFSS and 2013 UNICEF KAP)

Main variable	Prevalence of stunted children (2013 YNHDS; 2011 CFSS) Prevalence of wasted children (2013 YNHDS; 2011 CFSS)		
Immediate determinants	Low-birth weight prevalence (WHO estimates)	Minimum Diet Diversity among children aged 6-23 months (2011 CFSS; 2013 UNICEF KAP)	Diarrhoea incidence among children under five years of age (2013 UNICEF KAP; 2013 YNHDS)
Risk factors and practices	Nutritional status of women of reproductive age (WHO estimates; 2011 CFSS) Total fertility rate (2013 YNHDS) Births by age 15 and by age 18 (2013 YNHDS)	Child feeding practices (2011 CFSS; 2013 UNICEF KAP) Breastfeeding practices Use of 4+ food groups Use of animal-based food sources Use of Vitamin-A rich foods Feeding frequency	Household hand-washing (2013 UNICEF KAP) Household safe disposal of child faeces (2013 UNICEF KAP) Household defecation in open bush/field (2013 UNICEF KAP)
Public interventions	Access to family planning services (2013 YNHDS) Access to Ante-Natal Care (2013 YNHDS; 2013 UNICEF KAP) Delivery by a skilled provider (2013 YNHDS; 2013 UNICEF KAP) Delivery in a health facility (2013 YNHDS; 2013 UNICEF KAP)	Promotion of Infant and Young Child Feeding (IYCF) practices in health facilities or hospitals (2013 UNICEF KAP) Vitamin A supplementation (2011 CFSS)	Treatment of child diarrhoea (2013 YNHDS) Household access to improved water sources (2013 CFSS, 2013 UNICEF KAP) - including distance (2013 UNICEF KAP) Household access to improved sanitation facilities (2013 CFSS, 2013 UNICEF KAP)
Household characteristics	Household Food Consumption Score ⁸ (2011 CFSS) Household Wealth Index ⁹ (2011 CFSS) Household expenditures (2011 CFSS) Household livelihood strategies (2011 CFSS) Household exposure to different types of shocks (2011 CFSS)		
Residence	Urban and rural (2011 CFSS; 2013 YNHDS) Agro-ecological areas (2011 CFSS)		

Source: Author

⁸ Food Consumption Score is a proxy indicator of the current food security situation reflecting both food availability and food access at household level. It is a composite score based on the dietary diversity, food frequency, and relative nutritional importance of various food groups consumed by a household.

⁹ The Household Wealth Index involves the Principal Component Analysis (PCA) of variables relating to ownership of assets and housing conditions. Used to divide households into quintile that can be more easily described.

4.3 Second research objective: Conducting the quantitative analysis

4.3.1 Variables included in the quantitative analysis

4.3.1.1 Child nutritional status

For the regressions, the standardised z-scores were transformed into binary variables for defining whether a child is stunted or not. As recommended by WHO, a child is defined as being stunted if the median height-for-age z-score is below -2 SD. A child is defined as being severely stunted (wasted) if the median height-for-age is below -3 SD.

4.3.1.2 Immediate determinants of child stunting

The 2011 CFSS dataset only provided data on the complementary feeding practices for children 6-23 months and on the incidence of diarrhoea in the previous two weeks.

For complementary feeding practices, the regression used data on child diet diversity and on child access to animal-protein food groups.

4.3.1.3 Risk factors, practices and public interventions associated to child stunting

The only available data in the 2011 CFSS dataset on the nutritional status of women of reproductive age were on the Mid-Upper Arm Circumference (MUAC). The quantitative analysis applied the cut-off point of acute malnutrition (MUAC < 22.2 cm) as a proxy for maternal malnourished status.

The number of children under 5 years of age per mother was used as a proxy for birth spacing. The only available variable related to a nutrition-specific public intervention was the supplementation of Vitamin A in the previous six months. No variables were available for any of the other health-based nutrition interventions. Attempts were made to use the 2013 UNICEF dataset but the quality of the data was too poor to get any significant result.

For the WASH sector, the 2011 CFSS dataset included variables on the household access to improved drinking water supply and to improved sanitation facility. No variables were available on food safety, quality of drinking water and on both the coverage of hygiene practices and related promotion interventions.

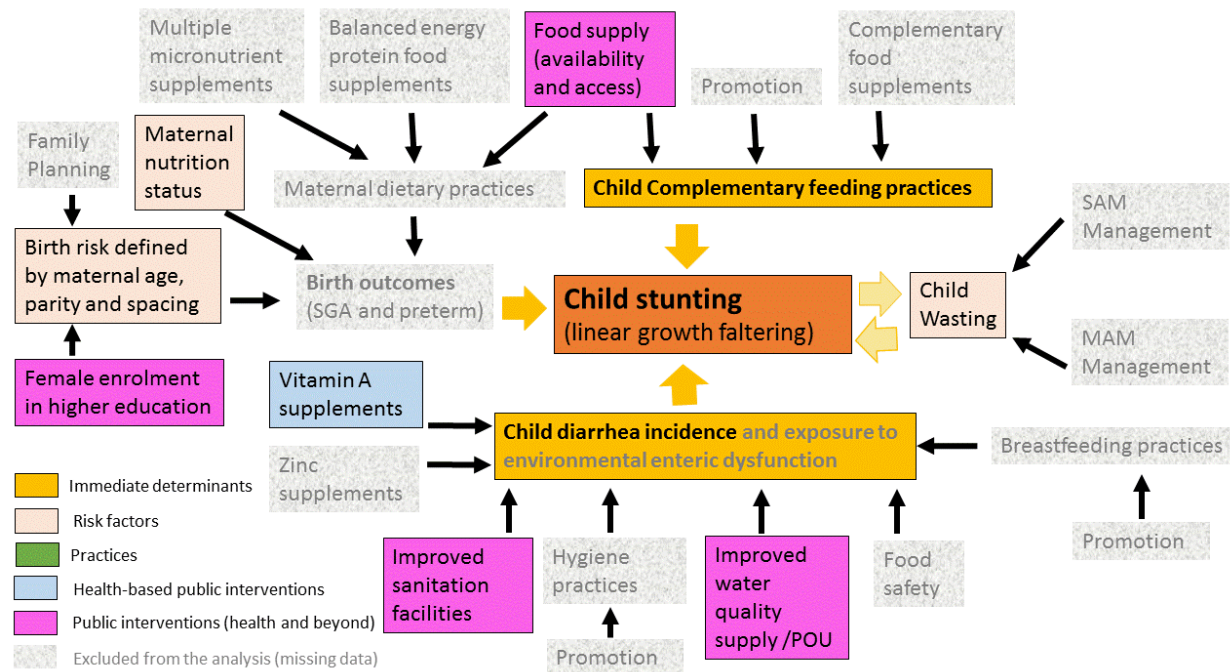
For the agriculture sector, the 2011 CFSS dataset included a wide range of variables at household level that are linked to the availability and accessibility of food supply such as livelihoods, expenditures, exposure to shocks and ownership to farming land. Additional variables were included in the regressions because of their specificity to the Yemen context such as the household expenditure on Qat and the household share of workers abroad.

Child, maternal and household characteristics were also analyzed in the regressions including the age and sex of the child, the household residency and the household agro-ecological location. Spouse illiteracy was the only variable available as a proxy for maternal education. The

regressions also looked at the ownership of a number of assets including a cooking stove, a fridge, a radio, a TV and access to electric light.

Details of the variables included in the quantitative analysis are provided in Annex 3, together with the definition and the typology of variable.

Figure 8: Applied conceptual framework in the quantitative analysis based on available data



Source: Author

Table 6: Overview of the variables included in the quantitative analysis (Source: 2011 CFSS)

Main variable	Prevalence of stunted children Prevalence of wasted children		
Immediate determinants		Minimum Diet Diversity among children aged 6-23 months	Diarrhoea incidence in the previous two weeks
Risk factors and practices	Maternal nutrition status Number of children below 5 years of age (proxy for birth spacing)	Child feeding practices Use of 4+ food groups Use of animal-based food sources	
Public interventions		Vitamin A supplementation	Household access to improved water sources Household access to improved sanitation facilities
Child and maternal characteristics	Child age and sex Maternal illiteracy		
Household characteristics	Household expenditures Household livelihood strategies Household exposure to different types of shocks Household ownership of assets Household head characteristics (gender, age, education)		
Residence	Urban and rural (2011 CFSS; 2013 YNHDS) Agro-ecological areas (2011 CFSS)		

Source: Author

4.3.2 Probit regression on child stunting and child wasting

The data was kept at child level, while making sure that the standard errors in the regressions were then clustered at household level. The analysis was performed at child level to better understand the determinants of child stunting. In terms of data availability, the 2011 CFSS collected key questions on feeding practices only for the sub-group of children between 6-23 months.

The dependent variables were Height-for-Age z-score (0/1 stunting and severe stunting) and Weight-for-Height z-score (0/1 wasting and severe wasting). These four dependent variables were modelled separately.

The model looked at the probability of child i from mother m in household h located in governorate v and agro-ecological area s (n_{cmhvs}) being stunted (wasted):

$$(n_{imhvs}) = \exp(c_{imhvs} + m_{mhvs} + x_{hvs} + k_{vs}) + \varepsilon_{imhvs}$$

Where C_{imhvs} is a vector of child-specific characteristics including demographics (child gender and child age months category), sickness incidence (whether the child experienced diarrhoea in the previous 2 weeks), access to health care (whether the child was given any vitamin A supplement in the previous 6 months) and diet diversity (whether a child consumed a number of food groups in the previous 24 hours).

Where m_{mhvs} is a vector of mother-specific characteristics including risk factors for child stunting such as child spacing (number of children below the age of 5 years) and maternal nutrition status (using mother's MUAC < 22.2 cm).

Where x_{hvs} is a vector of household-specific characteristics, which include gender of household head, age of household head, literacy of household head and his spouse, household size, (log) expenditure per capita, share of expenditures on qat, the ownership of assets (radio, TV and fridge), access to improved cooking stoves (LPG/Kerosene) and public electricity. For the access to sanitation facility, the applied dummy variable was given value 1 if the household has access to flush toilet and 0 if the household has access to a pit latrine or bush. For the access to improved drinking water, the applied dummy variable was given value 1 if the household has access to either piped water or public tap and 0 if the drinking water is from well, spring, river or tanker. In addition, two dummy variables were used that were given value 1 if the household is from a rural area and if the household has access to agricultural land. Given the importance of remittance in the economy of Yemen, the share of workers living abroad was also included in the model. In the basic specification of the model, wealth was included on its own without other assets. Because of the assumption that child nutrition status will be highly influenced by the type of agro-ecological area in which the household resides, 6 dummy variables for each area were included (temperate highlands, red sea and Tihama coast, Arabian sea, internal plateau, desert and dry highlands). Dummy variables for the governorate of household residence were also included to capture unobserved region level characteristics such as the access to basic services and to account for the remoteness of the household.

Where the ε_{imhvs} is the clustered error at the household level to account for errors that are not independently distributed. The household is chosen as the highest possible level given that the number of agro-ecological areas and governorates are too small.

4.3.3 Poisson regression on child diet diversity and access to animal-protein food groups

A more in-depth analysis was run to highlight the main factors associated with a diversified diet for children 6-23 months. The first dependent variable was composed by the number of food groups consumed by the child during the previous 24 hours and the second one by the number of animal-protein food groups consumed by the child during the previous 24 hours. Both variables could only take non-integer values, ranging from 0 to 7 in the case of diet diversity and from 0 to 3 in the case of animal-protein food groups. The Poisson model was chosen given the count-data nature of the variables. Several robustness checks using negative binomial models were run to account for over-dispersion issues.

The analysis included all household characteristics relevant to the Yemeni context such as education, wealth, exposure to shocks and agro-ecological location. In addition to these, a separate model was run to include the main livelihood strategies that the household engages in.

The model looked at the number of food groups consumed by child i from mother m in household h located in governorate v and agro-ecological area s (d_{cmhvs}) as the following:

$$(d_{imhvs}) = \exp(c_{imhvs} + m_{mhvs} + x_{hvs} + k_{vs}) + \varepsilon_{imhvs}$$

Where c_{imhvs} is a vector of child-specific characteristics including child gender and child age category. The child age category looks at the group 12-17 months and 18-23 months compared with the age 6-11 months. This reflected the expected variations in feeding patterns as the child grows older.

Where m_{mhvs} is a vector of mother-specific characteristics, which included the number of children below the age of 5 years in order to control for parity and spacing.

Where x_{hvs} is a vector of household variables, which include age of household head, literacy of household head and his spouse, household size, (log) expenditure per capita, share of expenditures on qat, the ownership of assets (radio, TV, fridge and cooking stove), the access to improved sanitation facility and drinking water supply and the access to public electricity. A set of shock dummies was included in the model to capture the three main adverse events, which affected the household in the previous 6 months. The types of shock distressing the households were grouped into seven categories: 1. high health expenditures; 2. high food prices; 3. Lack of/late rain; 4. insecurity/violence; 5. high debt to repay; 6. reduced remittances/wages and 7. loss of employment. The type of agro-ecological area in which the household resides was also expected to influence diet diversity. For this reason, 6 dummy variables were included for each area (temperate highlands, red sea and Tihama coast, Arabian sea, internal plateau, desert and dry highlands). Dummy variables for the governorate of residence were also included to capture unobserved regional level characteristics that might affect diet diversity.

Where ε_{imhvs} is the clustered error at household level to account for errors that are not independently distributed. The household is chosen as the highest possible level given that the number of agro-ecological areas and governorates are too small.

The main income activities of the household was added to the model in order to investigate the relationship between child diversity and household livelihood strategies. The livelihood classification was based on the income module of the household survey (2011 CFSS). This module asks to report on the relative contribution of up to four most important income generating activities in which the household was engaged in the preceding year. The CFSS income module takes into account the fact that, in the Yemeni context, the household income comes from multiple sources often in homogeneous combinations. The livelihood categories

included in the analysis were: 1. agriculture/livestock/fishery; 2. qat; 3. petty trade/collection of wood; 4. private business; 5. wage (non-government)/driver; 6. government salary and; 7. support income (remittances/Social Welfare Fund/pension). In the model, all livelihood strategies were compared to agriculture/livestock/fishery assuming that households within this category have direct access to foods, although not necessarily to income and wealth.

The reason for running this model separately came from the nature of such variables that might be endogenous. In particular, the relationship between household livelihood strategies and child diet diversity might be affected by unobserved characteristics that are correlated with both. If this was the case, the livelihood strategies and errors would not be uncorrelated and the coefficient for livelihood strategies would be biased. In this context it is not possible to tell in advance whether the bias is positive or negative. The results were reported because of the interest expressed by decision-makers.

In order to shed more light on the determinants of child diet diversity for the agricultural sector, a restricted analysis was also run on the children from 6-59 months, who lived in a household with access to land in 2011. Selected agricultural specific variables were added to the covariates included in the previous models. These included the ownership of livestock (divided by type of livestock – cattle, poultry, camels, donkeys and sheep and goats), the size of agricultural land (log) and whether the land was irrigated.

4.3.4 Interpretation of results

The results were reported in a table showing the marginal effects of the Probit regressions for stunting and severe stunting and for wasting and severe wasting. For each explanatory variable, the table shows the Coefficients, the Standard Errors and the associated P-values. The Coefficient is the effect of one unit change in the explanatory variable on the dependent variable. The Standard Error is the measure of the accuracy of the estimate of the coefficients. Any P-value less than .05 was considered statistically significant. A positive coefficient meant that an increase in the explanatory variables led to an increase in the predicted probability of a child being stunted, severely stunted, wasted or severe wasted. A negative coefficient meant that an increase in the explanatory variable led to a decrease in the predicted probability of a child being stunted, severely stunted, wasted or severe wasted.

Results were reported in a separate table showing the marginal effects from the Poisson regressions for the number of food groups consumed by the child during the previous 24 hours and for the number of animal-protein food groups consumed by the child during the previous 24 hours. For each explanatory variable, the table shows the Coefficients, the Standard Errors and the associated P-values. The Standard Error shows the measure of the accuracy of the estimate of the coefficients. Any P-value less than .05 was considered statistically significant. A positive coefficient meant that an increase in the explanatory variables led to an increase in the number of food groups consumed by the child. A negative coefficient meant that an increase in the explanatory variable led to a decrease in the number of food groups consumed by the child.

For the models to fit, the McFadden's Pseudo R-squared must always stay between 0 and 1. Higher values indicate better model fit. In a Probit regression what count the most for the interpretation of the results are the significance of the Coefficients and the associated low P-values. In addition, the most significant variables are those that show consistent Coefficients across all models.

The Pearson Goodness-of-Fit test was used to confirm how well the observed data correspond to the fitted (assumed) model. If the test had been statistically significant it would have indicated that the model would have not fit the data. The regression diagnostics suggested that for both dependent variables the Poisson model agrees with Pearson's test for goodness of fit.

Additional models were run to check the robustness of the results. The same regressions were run on a larger sample, including children from 6 to 59 months. The results are consistent, with some variables showing even stronger statistical significance in the models with bigger sample.

The first interpretation was to describe the relationship between the explanatory and the dependent variable. The main aim was to determine which explanatory variables are statistically significant and how changes in them relate to changes in the response variable. The results were expected to fit the key assumptions in the conceptual framework.

.4.3.5 Simple predictive simulations

The research included a sub-set of interventions from the LiST module. For the health sector, the following interventions were included in the simulation: iron folate supplementation for pregnant women, Vitamin A supplementation for children, management of severe acute malnutrition, management of moderate acute malnutrition, promotion of breastfeeding practices, promotion of complementary feeding practices and provision of complementary food supplements for children 6-23. For the education sector, the only included intervention was folic acid supplementation for adolescent girls.

The baseline coverage was based on data from population surveys (i.e. 2013 YNHDS, 2013 UNICEF and 2011 CFSS) and from programmes. The target coverage took into account the estimated costs for scaling up the interventions according to the available funds and value for money.

Expanding from the LiST module, one separate simulation was conducted on birth spacing, maternal education, drinking water supply and child minimum diet diversity. Even if quite informative, the interpretation of results from these types of simulations must be interpreted with caution. First, all other covariates included in the simulation were taken at their current mean values and, second, the relationship among the covariates was assumed to remain constant.

Looking at past trends was useful when deciding changes in covariates or in target coverages but it was more important to validate the assumptions with national experts.

4.4 Third research objective: Conducting the discussion with decision-makers

4.4.1 Getting a balanced set of stakeholders in the discussion

Participants were invited based on their individual influence or because of the institution they represented. Given its leading intergovernmental role, the Ministry of Planning and International Cooperation of Yemen convened the multi-sectoral consultation. Government representatives were from line Ministries including health, social protection, agriculture, education and WASH. Additional stakeholders included representatives from UN agencies with a nutrition mandate (UNICEF, FAO, WHO and WFP), from Non-Governmental Organizations, from donors and from research and academia institutes. A total of 26 participants attended the consultation. They spoke a medium to good level of English. Discussions in plenary were always in English while the group discussions were both in English and Arabic, except when summarizing key points. Female national participants represented 30% including decision-makers from Ministries, advisors from international organizations and representatives from non-government organizations.

4.4.2 Adapting the Delphi method

The key characteristics of the Delphi method can be summarized as follows: anonymity of the participants, structured information flow and regular feedback. On the advantages, anonymity frees participants from their personal biases, minimizes the conformity effect, allows free expression of opinions, encourages open critique, and facilitates admission of errors when revising earlier statements. The facilitator controls the interactions among the participants by processing the information and filtering out irrelevant content. Consensus is reached over time as opinions are influenced and changed. On the disadvantages, response times can be long, which slows the pace of discussion. It is also possible that the information received back from the experts does not provide distinctive value.

The Delphi technique can be adapted for use in face-to-face meetings, and is then called mini-Delphi (Pan et al. 1996). The method that was applied in the workshop with decision-makers from Yemen used the same key elements of the Delphi method with the key difference that participants knew each other and did not provide anonymous response. For this reason, additional measures were applied to address some of the common problems with group dynamics such as the conformity effect and the monopolization of the discourse by a small number of stakeholders. The use of questions interposed with continuous feedback was applied to address the conformity effect and ensure that participants felt encouraged and rewarded for expressing their views, including updating their earlier statements. To reduce the risk of monopolization, the information from the group work was continuously gathered around key issues that were discussed in plenary sessions. This ensured that the divergence was kept

around approaches rather than positions and that workable solutions could be identified on the way forward.

Most of the work informing this research was conducted during 2014 with strong engagement of key stakeholders in Yemen. While the research context is no longer the same, key aspects of the method used in 2014 were applied to inform the multi-sectoral emergency nutrition response that was put in place in late 2015.

Chapter 5: Results from the Yemen case

5.1 First research objective: results from the descriptive analysis

5.1.1 Child malnutrition

According to the most recent national survey (2013 YNHDS), Yemen remains a country with an extremely high prevalence of child malnutrition although it has made some progress over the past years in the reduction of child stunting.

The percentage of children who are stunted (below -2 SD) is 46.5% with about half of these (23%) severely stunted. Overall a slightly higher proportion of males (48%) are stunted compared to females (45%). In rural areas 51% of children are stunted, versus 34% of children in urban areas. Stunting prevalence steadily increases in the age group between 6 and 23 months and then flattens between 24 and 59 months. Stunting prevalence decreases as the level of mother's education increases, from a high of 54% among children of mothers with no education to a low of 24% among children of mothers with a higher education.

Sixteen percent of children under age five are wasted, with results showing a slightly higher proportion of males (18%) than females (15%). In rural areas, 17% of children are wasted, versus 14% of children in urban areas. The prevalence of wasting is more evident in infants under 18 months old with a peak between 6 and 8 months, which is commonly associated with poor weaning practices. However, Yemen has also a high incidence of wasting in infants less than six months old with 20% being moderately wasted and 9.2% severely wasted.

The 2013 YNHDS findings are close to the results of the 2011 CFSS, which reported 47% of children under five years of age being stunted with 51% in rural areas compared to 36% in urban areas but almost no difference between males and females (47% compared with 46%). According to the 2011 CFSS, 13% of children under five years of age were wasted with 3.7% severely wasted with a significant difference between males and females (15% compared with 11%) but not between rural and urban areas. The wasting prevalence in the 2011 CFSS is lower than the prevalence reported in the 2013 YNDHS.

Table 7: Nutritional status of children under five years of age measured by moderate and severe stunting (height-for-age) and by moderate and severe wasting (weight-for-height) by age, sex, residence and mother's education, Yemen 2013

Child Characteristics	Stunting (height-for-age)			Wasting (weight-for-height)			Mean Z-score (SD)	Number of children
	Percentage below -3 SD	Percentage below -2 SD	Mean Z-score (SD)	Percentage below -3 SD	Percentage below -2 SD ²	Percentage above +2 SD		
Age in months								
<6	7.9	19.2	-0.7	9.2	20.1	6.1	-0.7	1,421
6-8	10.4	27.6	-1.1	11.0	28.4	2.8	-1.2	723
9-11	11.3	26.4	-1.1	8.6	21.9	1.8	-1.1	661
12-17	18.5	38.0	-1.6	6.8	23.3	1.9	-1.0	1,649
18-23	24.9	49.8	-2.0	4.8	14.6	1.4	-0.8	1,130
24-35	30.2	55.5	-2.2	3.8	13.6	1.4	-0.8	2,782
36-47	28.5	57.8	-2.3	3.6	12.8	1.4	-0.8	2,664
48-59	25.6	54.0	-2.2	2.9	12.4	1.4	-0.9	2,793
Sex								
Male	24.4	47.6	-1.9	5.7	17.8	2.0	-0.9	7,019
Female	21.3	45.4	-1.8	4.7	14.7	2.1	-0.8	6,804
Residence								
Urban	13.1	33.7	-1.5	4.4	14.4	2.4	-0.8	3,813
Rural	26.6	51.4	-2.0	5.5	17.0	1.9	-0.9	10,010
Mother's education								
No education	28.6	53.7	-2.1	5.7	17.5	1.9	-0.9	7,403
Fundamental	17.5	40.1	-1.6	4.7	15.3	2.4	-0.8	4,396
Secondary	14.3	34.4	-1.5	4.4	14.8	1.4	-0.8	1,272
Higher	4.7	23.7	-1.1	3.6	13.8	2.9	-0.7	466
Mother's interview status								
Mother interviewed	22.8	46.4	-1.9	5.2	16.4	2.0	-0.9	13,447
Mother not interviewed, but in household	23.9	50.7	-2.0	4.9	13.2	3.3	-0.8	262
Mother not interviewed, not in household	25.0	45.8	-2.0	5.6	14.1	2.0	-0.8	112
Missing	*	*	*	*	*	*	*	2
Total	22.9	46.5	-1.9	5.2	16.3	2.0	-0.9	13,823

Source: Yemen National Demographic Health Survey (2013)

The prevalence of stunting among children under five years of age is the most consistent indicator for measuring changes in the nutritional status over a set time period. Wasting is most sensitive to seasonality and to the occurrence of sudden events and is therefore excluded from any trend analysis.

The table 8 shows that the trend in the prevalence of stunting has decreased in the past ten years, from 57.7% in 2003 to 46.5% in 2012 (1.2% point per year or 2.15% relative reduction per year).

Table 8: Prevalence of stunting among children under five years of age in four population-based surveys conducted in Yemen in 1997, 2003, 2011 and 2013

Survey	Year	Total child stunting (%)	Moderate child stunting (%)	Severe child stunting (%)
Yemen National Health Demographic Survey (YNHDS)	2013	46.5	23.6	22.9
Comprehensive Food Security Survey (CFSS)	2011	46.6	24.9	21.7
Yemen Family Health Survey (YFHS) Re-analyzed by WHO	2003	57.7	30.2	37.5
Yemen Demographic and Maternal and Child Health Survey (YDMCHS) Re-analyzed by WHO	1997	59.3	23.4	35.9

Note: All prevalence shown in the table are based on the 2006 WHO Growth Standards.

5.1.2 The immediate determinants of child stunting

5.1.2.1 Birth outcomes

Low-birth weight is defined by the World Health Organization (WHO) as weight at birth less than 2,500 grams. Low birth weight is used as a proxy indicator for preterm neonates (born before 37 weeks of gestation), Small for Gestational Age (SGA) neonates and for neonates with both conditions (preterm and SGA).

Unfortunately recent population based surveys have not reported data on low-birth weight, although WHO has estimated that 32% of infants in Yemen for the period 2000-2008 were born with a weight below 2,500 grams.

5.1.2.2 Risk factors for birth outcomes

5.1.2.2.1 Nutrition status of women in reproductive age (15-49)

Nutrition in relation to women is a key determinant of health during pregnancy, foetal growth and child-birth outcomes. The high prevalence of low-birth weight (LBW) may be a consequence of the poor nutritional status of women in reproductive age.

According to the WHO estimates for the period 2000-2008, overweight (Body Mass Index ≥ 25) affected 51% of women and obesity (Body Mass Index ≥ 30) affected 23% of women in Yemen. This was coupled with high prevalence of raised blood pressure (39%), raised blood cholesterol (34%) and raised blood glucose (11%). The WHO estimates for the period 2000-2008 also show that women of reproductive age were vulnerable to under-nutrition with thinness (BMI < 18.5) and short stature (< 160 centimetre) affecting 25% and 9% of them respectively. For the period 2000-2008, 12% of adolescent girls were found to be overweight and 4% obese.

Cultural barriers limit the collection of the Body Mass Index (BMI) in population-based surveys in Yemen. The Mid-Upper Arm Circumference (MUAC) is used as a proxy to measure the nutrition status of women of reproductive age. Findings from the 2011 CFSS show that 14.4 % of women of reproductive age are severely malnourished (MUAC < 21.3 cm) but with a significant highest prevalence among women between 15-19 years (25.2%) and between 20-24 years (15.6%) compared with the other age group. The percentage of malnourished women (MUAC < 22.2 cm) is 24.2%, which is consistent with the WHO estimates for thinness (25% with BMI < 18.5).

5.1.2.2.2 Fertility rate

The Total Fertility Rate (TFR) is a summary measure of the level of fertility. It can be interpreted as the number of children a woman would have by the end of her childbearing years if she were to pass through those years bearing children at the current observed age-specific rates.

If fertility were to remain constant at current levels, a Yemeni woman would bear an average of 4.4 children in her lifetime. However, rural women would give birth to nearly two more children during their reproductive years than urban women (5.1 versus 3.2, respectively).

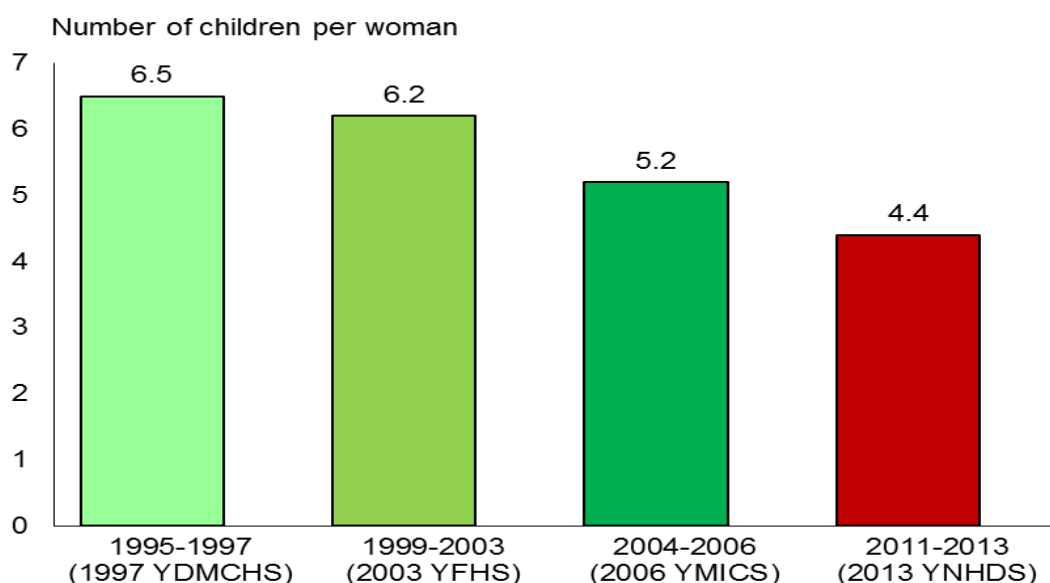
Fertility has declined from 6.5 births per woman in 1995-1997 to 4.4 births per woman in 2011-2013 — a drop of two births per woman in the past 16 years. The decline in fertility is most pronounced in the last ten years (1.8 children).

Table 9: The total fertility rate, the general fertility rate, and the crude birth rate for the three years preceding the survey, by residence, Yemen 2013

	Residence		Total
	Urban	Rural	
Total Fertility Rate (per 1,000 women aged 15-49 years)	3.2	5.1	4.4
General Fertility Rate (per 1,000 women aged 15-49 years)	111	163	145
Crude Birth Rate (per 1,000 population)	27.4	36.2	33.4

Source: Yemen National Demographic Health Survey (2013)

Figure 9: Trends in Total Fertility Rates expressed as number of children per woman, Yemen 1995-2013

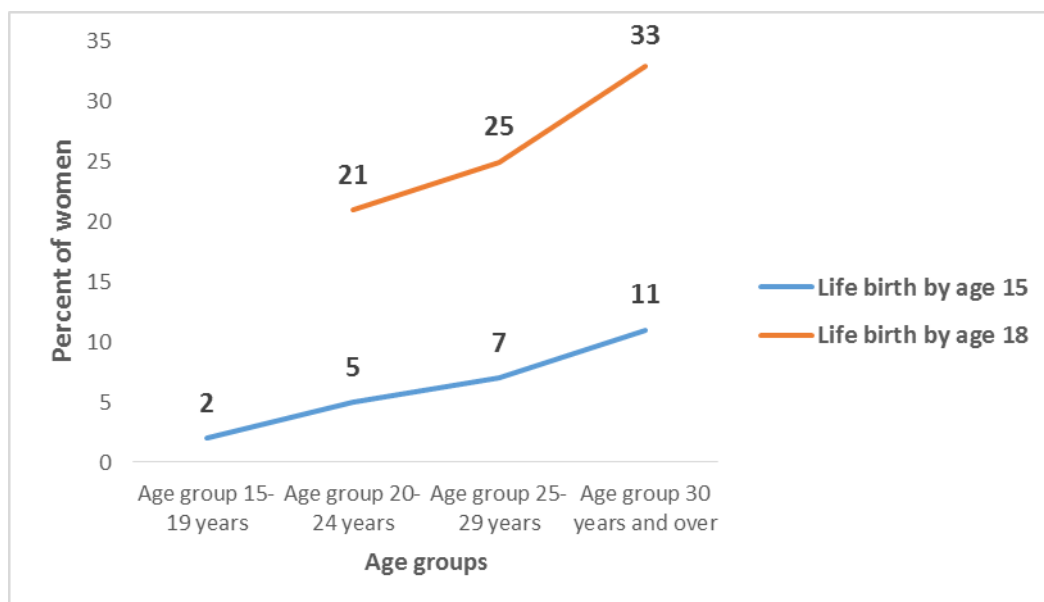


Source: Yemen National Demographic Health Survey (2013)

5.1.2.2.3 Early childbearing: births by age 15 and by age 18

According to the results from 2013 UNICEF Baseline survey in targeted rural districts (106 out of 333 districts), early childbearing is declining. Women over thirty years of age at the time of the survey were five times more likely to have had a birth by the age of 15 years compared with those in the age group 15-19 (11% compared with 2%). Similar observations can be made for women who had a live birth by the time they were 18 years, which includes births before the age of 15 years. One in three women in their thirties and above had a live birth by the age of 18 compared with about one in five women in their early twenties.

Figure 10: Percentage of women who had a live birth by the age of 15 and by the age of 18, Yemen 2013



Source: UNICEF Baseline Survey on Knowledge, Attitudes and Practices in 106 Yemeni districts (2013)

5.1.2.3 Appropriate complementary feeding practices for children 6-23 months

5.1.2.3.1 Breastfeeding practices up to 23 months

The 2013 YNHDS collected data on infant and young child feeding (IYCF) practices for all children born in the two years preceding the survey and living with their mothers. Already by 3 months, 31% of infants are given plain water, 32% are given milk other than breast milk and approximately 15% are already introduced to complementary foods. Almost 44% of infants under six months are fed using a bottle with a nipple; a practice discouraged by WHO because of the increased risk of diarrhoea and respiratory infections in unsanitary settings. As a result, only 10% of infants under 6 months are exclusively breastfed as per WHO recommendations.

Table 10: The status of breastfeeding among the youngest children under two years of age living with their mother by age, Yemen 2013

Percentage of youngest children under two years of age living with their mothers											
Age in months	Not breastfeeding (%)	Exclusively breastfed (%)	Breastfeeding and consuming plain water only (%)	Breastfeeding and consuming non-milk liquids ¹ (%)	Breastfeeding and consuming other milk (%)	Breastfeeding and consuming complementary foods (%)	Total (%)	Currently breast-feeding (%)	Number of youngest children under two years	Using a bottle with a nipple (%)	Number of all children under two years
0-1	6.3	21.0	37.2	4.7	25.6	5.2	100	93.7	445	32.9	445
2-3	5.5	7.4	26.7	2.1	37.2	21.0	100	94.5	645	46.9	648
4-5	8.2	5.0	15.3	3.2	25.2	43.1	100	91.8	554	49.0	561
6-8	12.5	0.9	8.6	1.1	14.7	62.3	100	87.5	794	49.5	806
9-11	19.8	0.1	4.0	1.7	3.5	70.9	100	80.2	739	45.2	743
12-17	30.0	0.2	1.7	0.5	1.8	65.8	100	70.0	1,697	40.2	1,797
18-23	49.0	0.5	0.4	0.2	0.6	49.3	100	51.0	1,032	31.7	1,231
0-3	5.8	13.0	31.0	3.2	32.5	14.6	100	94.2	1,089	41.2	1,093
0-5	6.6	10.3	25.7	3.2	30.0	24.2	100	93.4	1,643	43.8	1,654
6-9	14.1	0.7	7.7	1.3	11.7	64.6	100	85.9	1,112	48.2	1,124

Note: Breastfeeding status refers to a "24-hour" period (yesterday and last night). Children who are classified as breastfeeding and consuming plain water only consumed no liquid or solid supplements. The categories of not breastfeeding, exclusively breastfed, breastfeeding and consuming plain water, non-milk liquids/juice, other milk, and complementary foods (solids and semi-solids) are hierarchical and mutually exclusive, and their percentages add to 100%. Thus children who receive breast milk and non-milk liquids and who do not receive other milk and who do not receive complementary foods are classified in the non-milk liquid category even though they may also get plain water. Any children who get complementary food are classified in that category as long as they are breastfeeding as well.

¹ Non-milk liquids include juice, juice drinks, clear broth or other liquids

Source: Yemen National Demographic Health Survey (2013)

The 2013 YNHDS results on breastfeeding practices are similar to the findings from the 2011 CFSS, which found that just 11.6% of children were only breastfed with no significant difference between rural and urban areas (11.5 and 12.6, respectively). Results from the 2011 CFSS show that only 32% of children 6-23 months are breastfed while consuming at least one other food item. The difference between rural and urban areas is not significant.

Table 11: Percentage of children between 6 and 23 months of age, who are breastfed and consume at least one other food items by age group and by residence, Yemen 2011

Percentage of children aged 6-23 months breastfed and consuming at least one other food items by residence			
Age in months	Urban (%)	Rural (%)	National average (%)
6-11	29.0	31.6	30.8
12-17	37.1	33.3	34.4
18-23	32.4	28.8	30.0
Total	33.1	31.5	32.0

Source: Comprehensive Food Security Survey in Yemen (2011)

Results from the 2013 UNICEF Baseline in targeted rural districts (106 out of 333) show that 75% of mothers initiated breastfeeding within the first 24 hours after they gave birth but only 26% did so within the recommended first hour after birth. Findings show that 19% of children up to six months are exclusively breastfed and almost half of them are predominantly breastfed with no difference between males and females. Infants whose mothers did not attend school were significantly more likely to be exclusively breastfed than children whose mothers did attend school (23% compared with 13%). Findings show that 81% of children between 12-15 months were breastfed with no difference by gender or maternal education. However, the practice of breastfeeding was found to decrease significantly as the child approaches 23 months. Key findings are consistent with the observations made in focus group discussions conducted during the 2013 UNICEF Baseline. The vast majority of the focus-group participants believed that breast milk is not adequate and should be supplemented by water and other types of milks. The majority of participants also believed that complementary foods should be introduced as early as three months. The participants highlighted financial constraint as the main reason for practicing exclusive breastfeeding for the first six months.

5.1.2.3.2 Complementary feeding practices among children 6-23 months

The 2013 YNHDS report does not provide any results for complementary feeding practices for children aged 6-23 months. The 2011 CFSS provides information on the minimum diet diversity (MDD) of children which is defined as having consumed four or more food groups out of seven groups (grains, roots and tubers; legumes and nuts; dairy products; flesh foods; eggs; vitamin A rich fruits and vegetables and other fruits and vegetables). Information on complementary feeding practices provided by caregivers were based on a recall time of 24 hours. Results show that 20% of children 6-23 months are provided with the minimum diet diversity and only 5% were also breastfed to meet the minimum adequate diet. There is a slight increase of rates for minimum diet diversity among children between 18-23 months but it does not go over 25%.

Table 12: Percentage of children between 6 and 23 months of age consuming a minimum diet diversity and a minimum adequate diet by age group, Yemen 2011

Age in months	Children consuming < 4 food groups (%)	Children consuming ≥ 4 groups Minimum Diet Diversity (%)	Children breastfed and consuming ≥ 4 groups Minimum Adequate Diet (%)
6-11	80.5	19.5	5.7
12-17	82.4	17.6	4.7
18-23	75.4	24.6	5.9
Total	79.7	20.3	5.4

Source: Comprehensive Food Security Survey in Yemen (2011)

The World Health Organization (WHO) recommends that children between 6-23 months consume foods rich with animal protein and Vitamin A on a daily or regular basis. In Yemen, only 15% of children consumed Vitamin A rich foods and 33% consumed meat, fish, and/or eggs. The situation does not improve for children aged between two and five years where only

11% consumed Vitamin A rich foods and 33% ate animal based proteins. Coupled with poor Vitamin A supplementation, there is a real concern that Yemeni children are at increased risk of suffering from micronutrient deficiencies.

Table 13: Percentage of children between 6 and 23 months of age consuming animal-based food sources, Vitamin A rich foods and provided with Vitamin A supplements in the previous six months by age groups, Yemen 2011

Age months	Children consuming meat, fish and/or eggs (%)	Children consuming Vitamin A rich foods (%)	Children provided with Vitamin A supplements in the previous 6 months (%)
6-11	26.8	17.2	32.6
12-17	31.3	13.7	35.9
18-23	41.8	13.4	31.7
Total 6-23	33.1	14.7	33.6
24-59	33.0	10.7	36.1
Total	33.0	12.2	35.1

Source: Comprehensive Food Security Survey in Yemen (2011)

Most detailed information on complementary feeding practices are found in the 2013 UNICEF Baseline survey, which adheres to the WHO young child feeding recommendations by looking at the timely introduction of solid foods at six months, as well as appropriate meal frequency and dietary diversity.

The results from the 2013 UNICEF Baseline survey in targeted rural districts (106 out of 333 districts) show that only 38% of infants between six and eight months old consume solid or semi-solid foods, with no difference between males and females, or if the mother did or did not attend school, or by geographic location. Children who are no longer breastfeeding at this age are nearly twice more likely to be consuming solid or semi-solid foods than children who are still breastfeeding (65% compared with 35%). This may indicate that solid food is treated as a substitute rather than a complement to breast milk. These findings are consistent with those in the 2011 CFSS.

Minimum meal frequency is defined as receiving solid or semi-solid foods twice a day or more for infants between 6-8 months who are currently breastfeeding. Breastfed children between 9-23 months should have three or more meals involving solid or semi-solid foods while milk should be added for at least four times a day for non-breastfed children between 6-23 months. The results from the 2013 UNICEF Baseline survey show that only 33% of children between 6 - 23 months consume the minimum number of meals per day with no difference by gender, maternal education or geographical location. However, 42% of children between 18-23 months children eat the minimum number of required meals compared with 27% among infants between 6-11 months.

Only 14% of children between 6-23 months consume the recommended minimum diet diversity with no difference by gender or geographic location. As for the minimum meal frequency,

infants between 6-11 months are less likely to receive the recommended minimum diet diversity compared with children between 18-23 months (8% and 19% respectively). Maternal education matters: 20% of children whose mothers attended school consume the recommended minimum diet diversity, compared to 13% of children whose mothers did not attend school.

Only 5% of children between 6 -23 months consume the minimum adequate diet in terms of meal frequency and diet diversity with no significant differences between breastfed and non-breastfed children, males and females, age groups or geographic location. However, 9 % of children whose mothers attended school consume the minimum adequate diet in terms of frequency and diversity, compared to 4% of children whose mothers never attended school.

In summary, child age matters for the minimum frequency of the meals and for the minimum diversity of the diet but not for the minimum adequate diet. Maternal education matters for the minimum dietary diversity and for the minimum adequate diet but not for the minimum meal frequency. Child gender or child geographic location do not matter for any of the complementary feeding practices.

5.1.2.4 Diarrhoea incidence among children under the age of five

In the 2013 YNHDS, for each child under age five, mothers were asked if the child had experienced an episode of diarrhoea in the two weeks preceding the survey. Based on the mothers' recollection, 31% of children under age five had diarrhoea in the two weeks preceding the survey.

Findings are confirmed by the 2013 UNICEF Baseline survey in targeted rural districts (106 out of 333 districts) show that 39% of children in targeted rural districts (106 out of 333 districts) suffered an episode of diarrhoea two weeks preceding data collection. Girls are more likely to suffer from diarrhoea than boys (41% compared to 37%). The prevalence of diarrhoea is highest among children around their first and second birthday (51%) and lowest for infants less than six months old (36%) or children between three and five years old (27%). There is no difference by maternal education while there is a significant one by geographical location. Diarrhoea significantly increases a child's risk of being stunted: 41% of children suffering from diarrhoea were stunted compared to 36% of children who were not ($p \leq 0.001$). Similarly 44% of children suffering from diarrhoea were wasted compared to 38% who were not ($p \leq 0.05$).

5.1.3. Interventions linked to the immediate determinants of child stunting

5.1.3.1 Interventions to address poor birth outcomes

5.1.3.1.1 Family planning services to space or limit child bearing

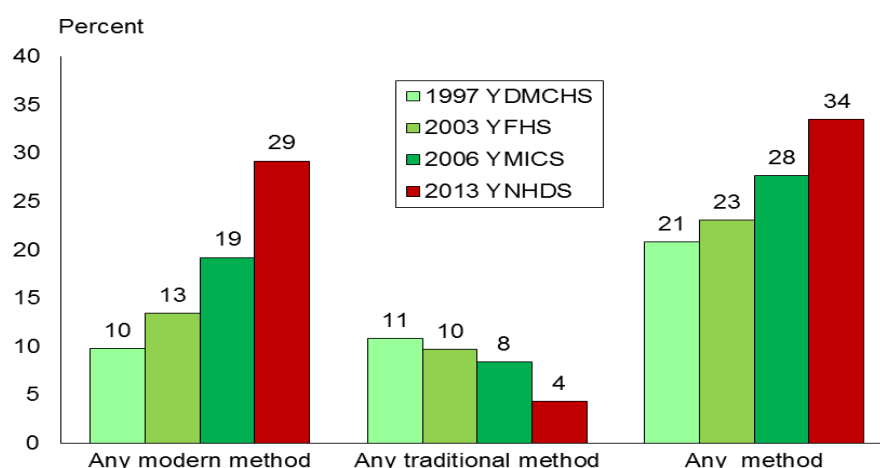
Information on fertility preferences is used to assess the potential demand for family planning services for the purposes of spacing or limiting future childbearing. The results from the 2013 DHS shows that 20% of currently married women want to have another child soon (within the next two years) and 24% want to have another child later (in two or more years). 39% of married women say they want no more children. Fertility preference is closely related to the number of living children.

More than three out of four women with no living children (77%) want a child soon, compared with only 3% of women with six or more children who still want another child in the next two years. The higher the number of existing children the higher the likelihood that the mother does not want another child (1.4% of women with no living children compared with 71.7% with six or more children).

Overall, 34% of currently married women are using a method of family planning, with 29% employing a modern method and 4% using a traditional method. The most popular methods are the contraceptive pill (12%), intra-uterine device (6%), injectable (4%), Lactation Amenorrhoea Method (4%) and female sterilization (2%). The contraceptive prevalence increases with age, reaching a peak at age 30-39 years (40%) and with the number of living children, reaching a peak for women with three or more children (42%). The use of modern methods is 40% among urban women and the corresponding rate in rural areas is 24%. Contraceptive use also increases with the mother's educational attainment.

Data from four surveys conducted in Yemen over the past 16 years show an impressive increase in the use of contraceptive methods with an uptake of modern methods by 190% and a decrease of traditional methods by almost half since 2006.

Figure 11: Trends in the prevalence of contraceptive methods (modern, traditional and both) among women of reproductive age (15-49 years old), Yemen 1997-2013



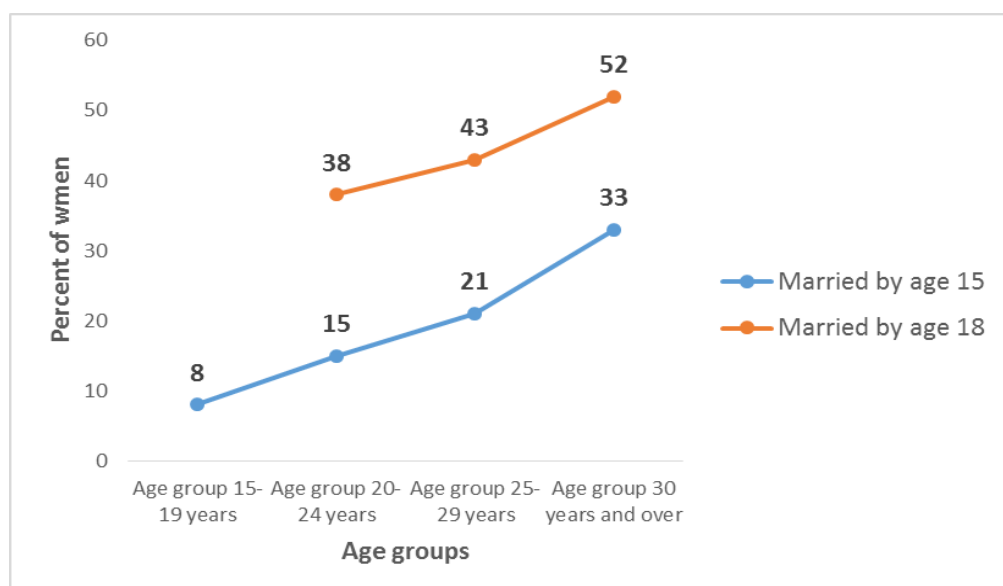
Source: Yemen National Demographic Health Survey (2013)

Women who say they are not using contraception and who say either that they do not want any more children, or that they want to wait two or more years before having another child are considered to have an unmet need for family planning. Conversely, women using a family planning method are said to have a met need for family planning. Both unmet need and met need can be categorized based on whether the need is for spacing or limiting births. The combination of women with unmet need and women with met need for family planning constitutes the total demand for family planning. The total demand for family planning among currently married women is 62% with 34% of them having a met need for family planning (16% for spacing and 18% for limiting) and 29% of them having an unmet need for family planning (15% for spacing and 14% for limiting). Women younger than 30 years have a higher unmet need for spacing while women age 30 or older have a higher unmet need for limiting. Rural women (33%) and those with no education (33%) are much more likely to have unmet need for family planning than urban women (20%) and those with secondary or higher education (22 and 15%, respectively).

5.1.3.1.2 Addressing early marriage to reduce pregnancy by age 15 and by age 18

According to the results from the 2013 UNICEF Baseline survey in targeted rural districts (106 out of 333 districts), early marriage is declining. The declining trend is very similar to the one in early pregnancy. This reflects the fact that almost all pregnancies in Yemen are within the wedlock. As shown in Figure 10 women in their thirties and above are significantly more likely to have been married at 15 or 18 years old when compared to younger women.

Figure 12: Percentage of women who were married by the age of 15 and by the age of 18, Yemen 2013



Source: UNICEF Baseline Survey on Knowledge, Attitudes and Practices in 106 Yemeni districts (2013)

Women who attended school are half as likely to get married early and to have a teenage pregnancy when compared to women that never enrolled in school. The comparison is 11% versus 24% for marriage by the age of 15, 27% versus 47% for marriage by the age of 18 and 6% versus 11% for women aged 15-19 who have had a live birth.

Girls are significantly less likely than boys to transition from grade six to grade seven (86 versus 96%). The drop-out coincides mainly with the onset of puberty and an increased risk of being forced into early marriage or child domestic labour (2013 UNICEF).

5.1.3.1.3 Maternal Health Care

In the 2013 YNHDS, mothers were asked whether they had obtained antenatal care during the pregnancy for their most recent live birth in the last five years. For each live birth over the same period the mothers were also asked what type of assistance they received at the time of delivery.

The 2013 YNHDS results show that 60% of ever-married women 15-49 years who had a live birth in the five years preceding the survey received antenatal care (ANC) from a trained health professional at least once for their last birth. Urban women were much more likely to have received ANC from a health professional than rural women (80% compared with 51%). Antenatal care was most common among women with higher education (93%).

Results from the 2013 YNHDS are consistent with those from the 2013 UNICEF Baseline survey in targeted rural districts (106 out of 333 districts), which showed that 46% of ever-married

women received antenatal care during their pregnancy. However, the overwhelming majority consulted a physician (90%) and only few women visited a midwife (5%), nurse (3%), traditional birth attendant (1%) or community health worker (1%). No data is available on the routine supplementation of Iron and Folic Acid (IFA) as part of ANC. The frequency of ANC visits are often used as a *proxy* with four visits taken as the minimum follow up to the recommended supplementation. According to the 2013 UNICEF Baseline survey, only 25% of women with a live birth had four or more ANC visits, 19% three visits and 29% only one visit. The frequency of visits did not differ by level of maternal education.

Seventy-three percent of births to urban mothers were attended by a health professional and 49% were delivered in a health facility, compared with 34% and 23%, respectively, of births to rural women. Mothers' educational status at parity of rural/urban location was highly correlated with delivery assisted by a health professional and birth delivered in a health facility. Only 31% of births to mothers with no education were attended by a health professional and 21% of births were delivered in a health facility compared with 89% and 65%, respectively, of births to mothers with higher education.

Table 14: Percentage of ever-married women (15-49 years) receiving ante-natal care from a skilled provider and percentage of births delivered by a skilled provider or in a health facility, Yemen 2013

Mother's characteristic	Ever-married women receiving antenatal care from a skilled provider* (%)	Number of ever-married women	Births delivered by a skilled provider* (%)	Births delivered in a health facility (%)	Number of births
Mother's age at birth					
<20	62.0	1,192	50.9	33.1	2,109
20-34	61.4	7,398	44.9	29.9	11,521
35+	51.4	1,779	37.5	26.0	2,250
Mother's education					
No education	47.9	5,475	31.0	21.2	8,765
Fundamental	68.7	3,463	56.3	36.6	5,123
Secondary	79.8	1,025	69.8	44.9	1,446
Higher	93.0	407	88.8	64.5	546
Mother's residence					
Urban	79.9	3,077	73.0	49.1	4,301
Rural	51.3	7,292	34.1	22.6	11,579
Total	59.8	10,369	44.7	29.8	15,880

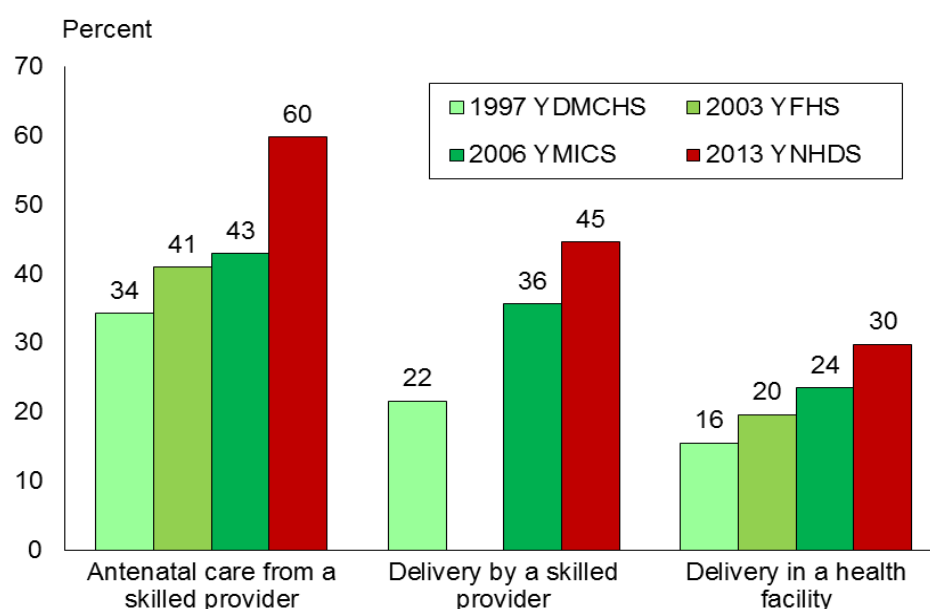
Source: Yemen National Demographic Health Survey (2013);

*Skilled provider includes doctor, nurse, midwife, or auxiliary midwife

The percentage of women who received ANC from a trained provider has increased substantially in the recent past, from 43% in 2006 to 60% in 2013. The percentage of births delivered by a health professional has increased in the recent past, from 36% in 2006 to 45% in

2013; the percentage of births in a health facility has also increased in the recent past, from 24% in 2006 to 30% in 2013.

Figure 13: Trends in the prevalence of ever-married women receiving ante natal care by a skilled provider and prevalence of births delivered by a skilled provider or in a health facility, Yemen 1997-2013



Source: Yemen National Demographic Health Survey (2013)

5.1.3.2 Interventions to improve appropriate complementary feeding practices for children 6-23 months.

According to the literature (see Chapter 2) public health interventions such as facility-based education and peer-counselling are expected to have a positive effect on the improvement of Infant and Young Child Feeding (IYCF) practices, especially on exclusive breastfeeding for the first six months.

Results from the 2013 UNICEF Baseline survey in targeted rural districts (106 out of 333) showed that women who did give birth in a health facility were significantly less likely to initiate breastfeeding within an hour after birth (15%) when compared with women who gave birth at home (29%). This resonates also with observations made in focus group discussions where for women who gave birth in a health centre or hospital fewer indicated that they were helped to initiate breastfeeding compared to women who had given birth at home.

Appropriate IYCF counselling as a minimum should actively promote the initiation of breastfeeding within one hour after delivery, exclusive breastfeeding for the first six months, timely introduction of complementary foods at six months and continuation of breastfeeding up to two years and beyond. Results from the UNICEF Baseline survey show no significant difference in appropriate IYCF practices either by child gender or by geographic location.

Mothers who have attended school were those most likely to attend ante-natal care, deliver in a health facility and seek child health care. In theory, educated mothers should have been the most exposed to the promotion of appropriate IYCF practices. In practice, educated mothers were less likely to apply initiation of breastfeeding within one hour and to exclusively breastfeed their child up to six months. However, educated mothers were more likely to provide the minimum diet diversity to their child between 6 and 23 months of age.

Key findings are consistent with the observations made in focus group discussions conducted during the 2013 UNICEF Baseline survey. The vast majority of the focus-group participants believe that public health services are poorly staffed and equipped and should be visited only if there is an emergency. Poverty was identified as the main factor that kept women from seeking antenatal care and assisted delivery. At the time of the survey, the Community Health Volunteer Programme was just being expanded and less than 1% of the households knew about the services or were acquainted with a trained volunteer.

5.1.3.2.1 Access to household diet diversity and risk factors

To be appropriate for the health of the mother as well as the child, a diet must be of sufficient quantity in terms of energy and adequate quality in terms of diversity. Findings from the literature review in Chapter 2 indicate that the availability of diet diversity for women of reproductive age is directly associated to improved birth outcomes and indirectly to reduced child stunting prevalence. Availability of a variety of foods, including animal-source proteins, is directly associated to improved diet among children aged 6-23 months and to reduced child stunting prevalence. While the specific requirements are different according to the stages in the life of an individual, an adequate balance of energy and protein can help to address the double burden of under-nutrition and over-weight or obesity, which is increasingly affecting the Yemen population.

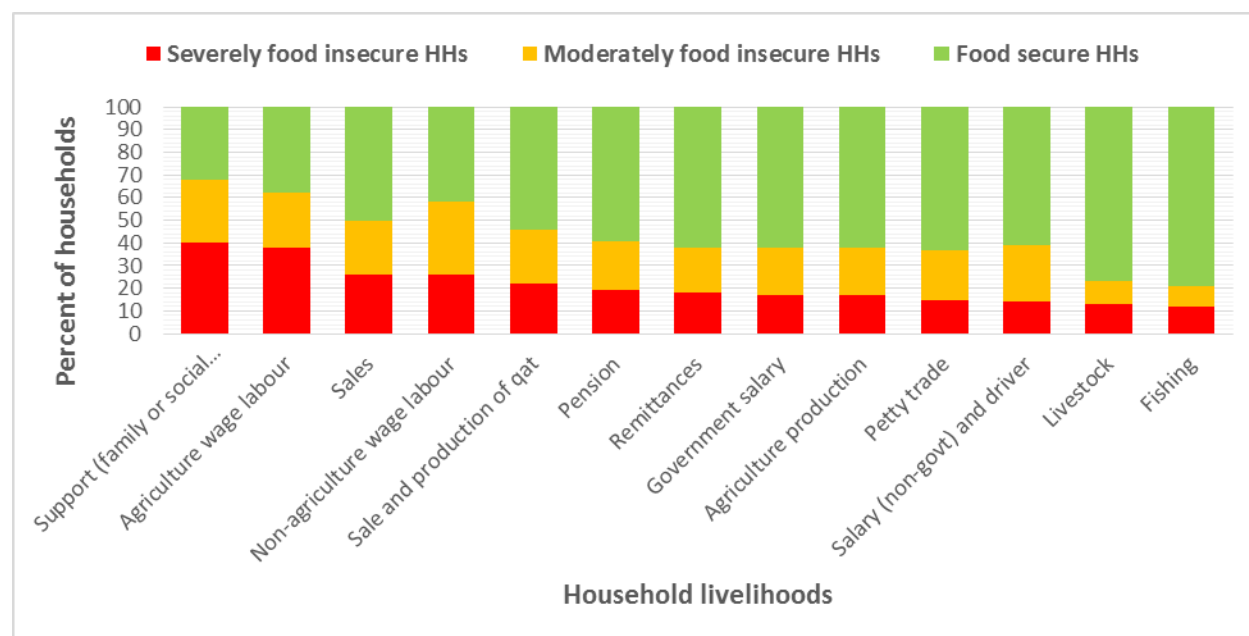
Results from the 2011 CFSS survey found that 44.5% of the population to be food insecure with 51% of the rural population to be food insecure compared to 27% in urban areas. Differences in the state of food security were also found between the surveyed governorates with 8 out of 19 having more than half of the population classified as food insecure. Among the six agro-zones, the Temperate Highlands had the highest prevalence of food insecurity followed by the Dry Highlands where 30% of the country's population is concentrated. In 2011, 22% of the population was found to be severely food insecure, which represented an almost double from 12% in 2009.

The 2011 CFSS survey looked at the daily consumption patterns over one week timeframe among three groups: 1) severely food insecure, 2) moderately food insecure and 3) food secure. Results show that the consumption of staples (grains, starches and roots), sugar/honey and oil and fats is quite similar while the biggest differences are found in the consumption of vegetables, fruits, pulses and animal-protein sources including meat and dairy products. Severely food insecure people never or rarely consume those key foods (range 0 to 1 day a week) compared to food secure people (range 1.3 to 3.8 days a week).

Female-headed households were found to be significantly more food insecure than male-headed households (52% compared to 44%). Larger households were found to be better off in terms of food consumption and wealth, mostly due to the number of adults able to earn an income.

Results from the CFSS module on household income showed the relative vulnerability to food insecurity by livelihood strategies linked to the household's ability to obtain food either through purchase or own production. The figure 12 shows that support receivers, including those dependent on family or the social welfare, have 40% of households classified as severely food insecure and another 28% as moderately food insecure. Agriculture wage labourers have respectively 38% and 24% severely and moderately food insecure.

Figure 14: Percentage distribution of household food security status by livelihood strategies, Yemen 2011

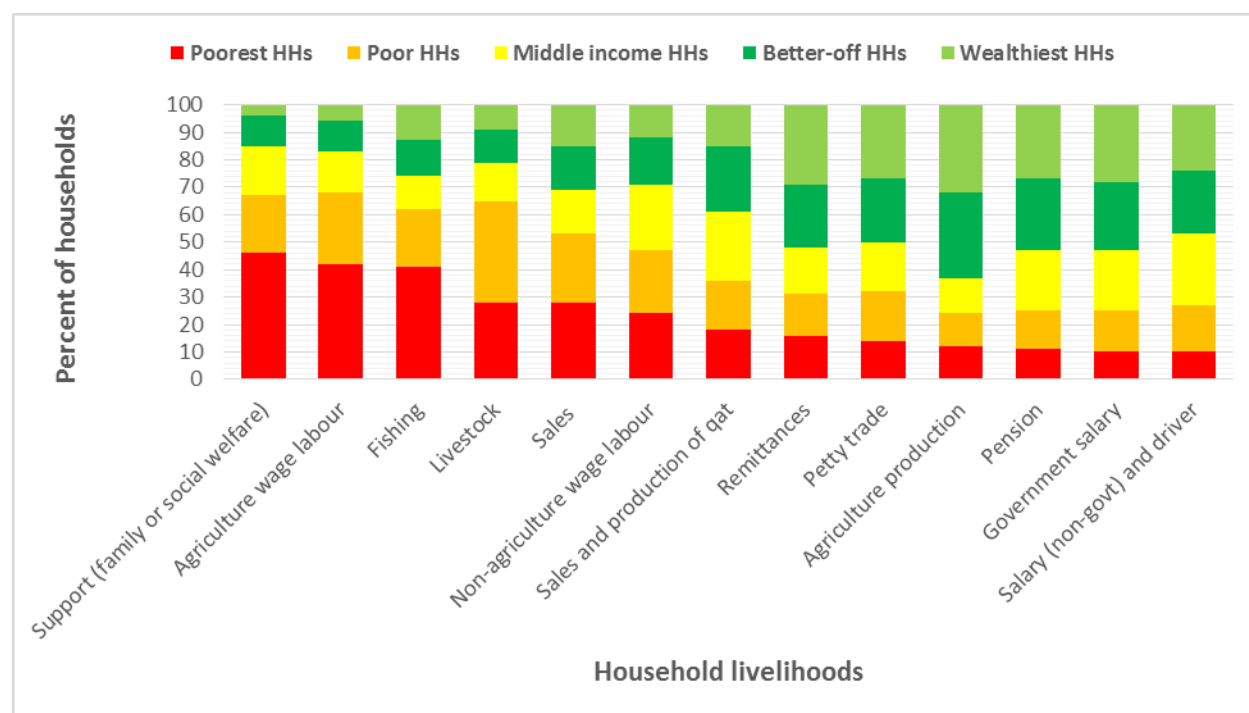


Source: Comprehensive Food Security Survey in Yemen (2011)

Households, whose main income is from fishing and livestock, have the highest access to a diversified diet, which includes animal protein sources. However, in terms of assets and housing characteristics, they account among the lowest wealth quintiles with 41% and 28% of

households classified as poorest. The figure 13 confirms that households dependent on agriculture wage and on welfare support are those that are both the most food insecure as well as the poorest.

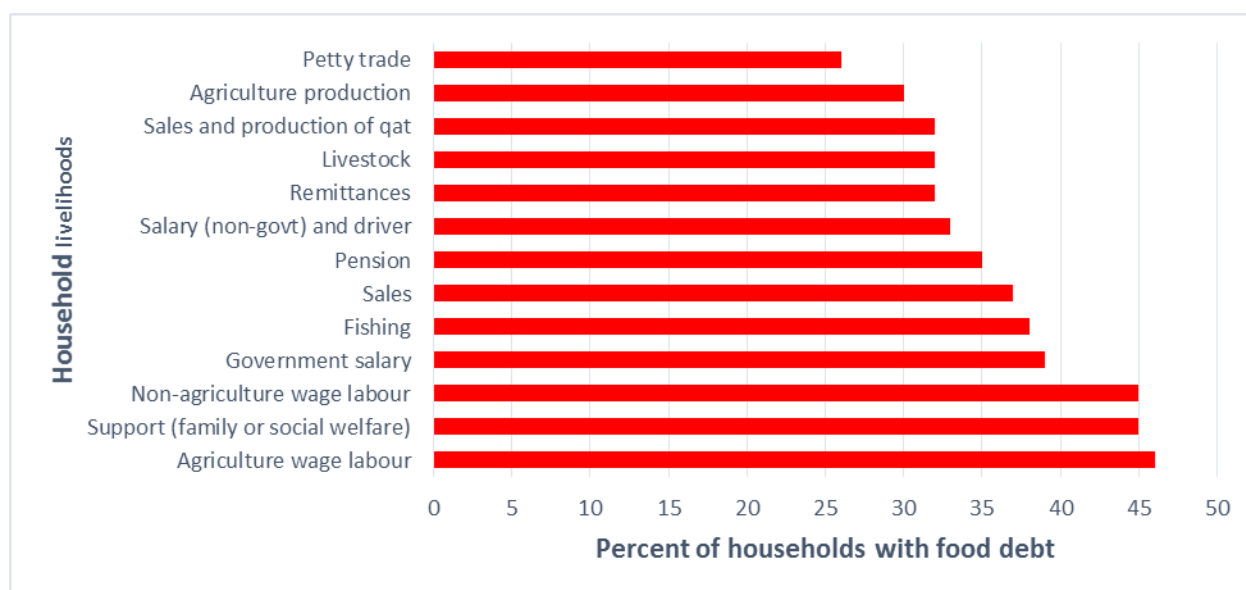
Figure 15: Percentage distribution of household wealth status by livelihood strategies, Yemen 2011



Source: Comprehensive Food Security Survey in Yemen (2011)

The 2011 CFSS report on current debt, shows that support receivers and wage labourers (agriculture and non-agriculture) have the highest percentage of food related debts. The lowest percentage registered among the petty traders may reflect the type of commercial transactions occurring in Yemen, whereby a large amount of small commodities, including food items, is purchased on credit.

Figure 16: Percentage of households with food debt by livelihood strategies, Yemen 2011



Source: Comprehensive Food Security Survey in Yemen (2011)

The 2011 CFSS asked the households to list the three main shocks that affected their life in the previous six months. The greatest majority of the households (90%) reported high food prices, followed by high fuel prices (41%) and high debt (20%). The purchasing power is highly dependent on international market dynamics. Yemen imports 90% of wheat, which is the most consumed staple. According to traders, the main causes of national food price increases in 2011 were higher wholesale prices for essential commodities such as grains, oil and sugar coupled by increased transport costs for perishable food items such as meat, eggs, milk, vegetables and fruits.

Despite the overall availability of food in almost all markets, the erosion of the purchasing power is the primary cause of food insecurity and reduced demand for diversified supply among the households. While the share of expenditure on food among all food security groups levels at around 45%, the severely food insecure households spend 35% on staples compared with the spending of 20% on staples among the food secure households. The latter spend on more expensive foods such as meat, dairy products, fruits and vegetables.

5.1.3.3 Interventions to reduce the incidence of child diarrhoea and exposure to environmental enteric dysfunction

5.1.3.3.1 Treatment of child diarrhoea

According to the 2013 YNDHS, treatment at a health facility or from a health provider was sought for 33% of children with diarrhoea. However, only 28% of children with diarrhoea received a rehydration solution in the form of Oral Rehydration Salts (ORS) or a recommended Oral Rehydration Therapy (ORT) such as a home-prepared fluid.

Female children, rural children and children of mothers with no education were substantially less likely to receive treatment from a health facility or health provider. However there was no significant geographic, gender or maternal education disparity in the treatment for diarrhoea using ORT or a solution from ORS package.

Table 15: Percentage of children under five years of age with diarrhoea by main characteristics and type of treatment, Yemen 2011

Child Characteristic	Children with diarrhoea			
	Children for whom treatment was sought from a health facility/provider (%)	Children given solution from ORS packet (%)	Children given any ORT (%)	Number of children with diarrhoea
Age in months				
<6	28.5	17.8	18.4	456
6-11	39.2	33.9	35.8	691
12-23	38.6	31.1	33.2	1,395
24-35	28.9	21.1	24.4	970
36-47	29.2	21.1	23.3	712
48-59	24.9	17.9	21.1	509
Sex				
Male	34.3	26.7	29.0	2,510
Female	31.2	23.7	26.0	2,223
Residence				
Urban	39.0	24.0	28.6	1,161
Rural	30.9	25.7	27.3	3,572
Mother's education				
No education	31.7	26.3	27.3	2,612
Fundamental	34.2	23.2	27.8	1,559
Secondary	29.7	26.8	29.0	436
Higher	50.1	23.0	27.2	126
Total	32.8	25.3	27.6	4,733

Source: Yemen National Demographic Health Survey (2013)

Findings are confirmed by the 2013 UNICEF Baseline survey, which showed that 26% of children in targeted rural districts were given a solution from ORS packet. There was no significant gender disparity in the treatment for diarrhoea but mothers who had attended school were more likely to give their children a solution from ORS packet (31% compared to 24%).

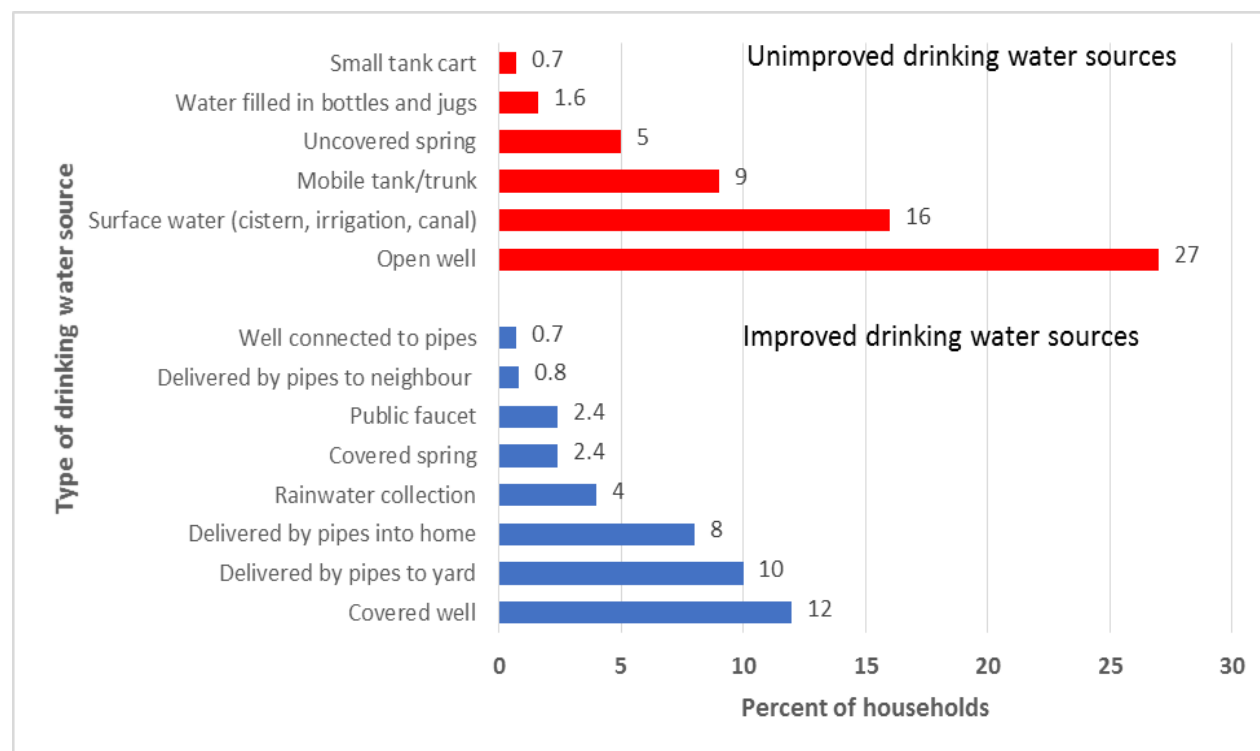
5.1.3.3.2 Improved access to drinking water supply, improved sanitation facilities and hygiene

According to the 2014 WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation, 54% of households have access to improved drinking water supply and 53% of households have access to improved sanitation facilities. While access to piped drinking water on premises has increased from 27% in 1990 to 40% in 2012, the overall improved drinking water coverage has decreased from 66% to 54% with a most concerning increase of unimproved drinking water coverage from 28% to 41%. Improved sanitation coverage has increased from 25% in 1990 to 56% (with only 3% shared facilities). Although still high, open defecation has been reduced from 44% to 22%.

The most comprehensive source of information on drinking water supply, sanitation and hygiene is the 2013 UNICEF Baseline survey in targeted districts (106 out of 333 districts). In terms of water supply, the survey collected data on the availability of improved or unimproved water sources and household water treatment practices. It also looked at who in the household was responsible for water collection and how much time it takes to fetch water. In terms of sanitation, the survey collected data on the access to improved and unimproved facilities, including the use of shared facilities. It also looked at how households dispose of child faeces. Data was also collected on hand-washing practices and on the availability of water and soap.

Compared with the national average, the coverage of improved drinking water sources was significantly lower in UNICEF target districts with only 41% of households using an improved drinking water source. At the time of the survey, only 12% of households accessed covered wells. An additional 10% of households had access to piped drinking water delivered in their yard and 8% of households to piped drinking water directly delivered into their home. Most households used unimproved drinking water sources with 27% accessing open wells, 16% surface water and 9% water delivered by tankers or trucks.

Figure 17: Percentage of households with access to unimproved or improved drinking water sources, UNICEF 106 target districts, Yemen 2013



Source: UNICEF Baseline Survey on Knowledge, Attitudes and Practices in 106 Yemeni districts (2013)

According to the results of the survey, water in the immediate vicinity (their own or neighbours' household) could be accessed by 27% of households. Almost one in three of the households (31%) spent more than one hour for the round-trip to collect water for household consumption. This increased to 40% for households accessing unimproved drinking water sources. Women 15 years of age or older were the ones who collected water in 61% of the households, followed by girls below 15 years in 18% of the households, men 15 years of age and older in 14% of the households, and boys below 15 years in 7% of the households.

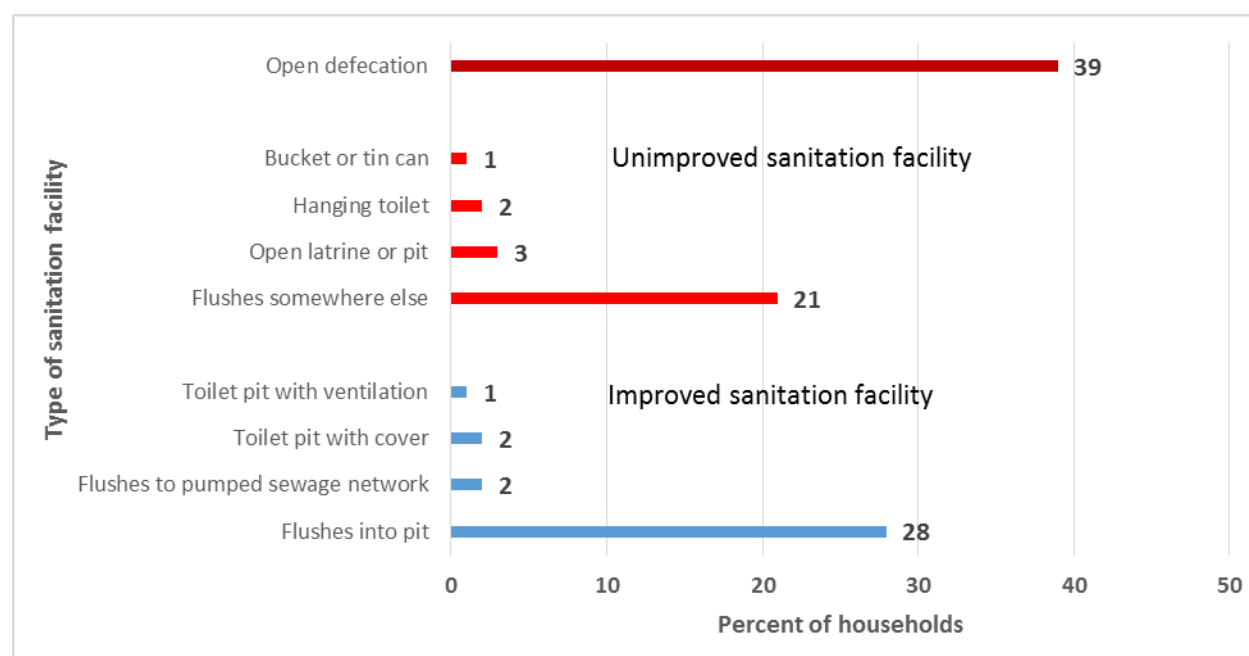
According to the findings from the 2013 UNICEF Baseline survey, households with an improved drinking water source were less likely to have a stunted child or a child with diarrhoea than households without improved drinking water sources. Though statistically significant, the difference was small with 39% versus 42% for stunting and 37% versus 42% for diarrhoea.

At the time of the survey, there were significant differences by geographic location in the coverage of improved drinking water sources, from 65% in the region with the highest access (Tihama) to 22% and 24% in the two regions with the lowest access (Highlands of Sana'a and east Hajja and the Nothern). Similarly Tihama was the only region where 57% of households had access to a drinking water source in their house or compound and where women were less likely to be the only person responsible to collect the water (40%). In all remaining regions

households invested substantial amounts of time into collecting water, with the highest share of responsibility falling into women and girls.

Compared with the national average of 56%, the coverage of improved sanitation facilities among households in the UNICEF target districts was 34%, with only 28% of the toilets flushing into a pit. Open defecation was practiced by 39 % of households and 27% used an unimproved toilet that flushes into the environment.

Figure 18: Percentage of households with access to improved or unimproved sanitation facilities and practicing open defecation, UNICEF target districts, Yemen 2013



Source: UNICEF Baseline Survey on Knowledge, Attitudes and Practices in 106 Yemeni districts (2013)

According to the 2013 UNICEF baseline findings, 59% of households whose head attended school were likely to have access to an improved sanitation facility compared with 41% of households whose head did not attend school. There was a significant geographic difference in the improved sanitation coverage from 51% in Tihama region to 21% in the Highlands of Sana'a and East Hajja. The range of open defecation went from 53% in Northern Lowlands to 19% in Southern Lowlands.

Nearly one in two households (43%) were leaving the faeces of their young children in the open. This habit was most prevalent among households practicing open defecation (65%) but it was also common among households with access to an improved or an unimproved sanitation facility (26% and 35% respectively). Only 29% of households disposed of child faeces in the trash. There was no significant geographic difference in the way households disposed of child faeces.

More than one in three households (36%) were found to not have a hand-washing place in their yard. The lack of a hand-washing place ranged from 68 % in Northern Lowlands to 21% in the Highlands of Dhamar, Rayma and Ibb. Water and soap were found to be available in 70 % of the examined hand-washing places, or upon request in 74% of the households. Observations from the focus group discussions reported a gap between the knowledge and the practice of hand-washing. Most men mentioned washing their hands with soap after handling pesticides or diesel while women mentioned washing their hands with soap prior eating.

5.2 Second research objective: results from the quantitative analysis

5.2.1 Variables associated with a child between 6 and 23 months being stunted and severely stunted

The quantitative analysis was performed using a dataset from the 2011 CFSS on a sub-sample of 3,296 children between 6 and 23 months. The aim was to explore in more depth some of the findings emerging from the desk review of the main surveys (i.e. 2013 YNHDS, 2013 UNICEF Baseline and 2011 CFSS). The table 16 reports the marginal effects of the Probit regressions for stunting and severe stunting among the sub-sample of children 6-23 months. McFadden's Pseudo R-squared is used as a measure of model fit. The values are between 0 and 1 and indicate that the model fit.

According to the results, a girl has a lower probability of being stunted by 7.9 percentage points compared to a male child, on average ($p < 0.01$). The effect is slightly lower for severe stunting. In line with the evidence from the literature, the analysis shows that the probability of being stunted increases by 13.7 percentage points in the age group 12-17 months and by 22.9 percentage points in the age group 18-23 months compared to the age group 6-11 months ($p < 0.01$). The effect is slightly lower for severe stunting.

The regression shows that the number of children below 5 years of age per mother is positively associated with the probability of a child being stunted or severely stunted ($p < 0.01$). Mother's Mid-Upper Arm Circumference (MUAC), a good predictor of mother's nutritional status, was highly associated to the probability of a child being stunted or severely stunted (6.6 percentage point and 6.7 percentage point respectively). In addition a household with a female-head is 11.7 percentage points more likely to have stunted children compared to a household with a male-head. Other household-characteristics such as household head education, household head age, household size and spouse education were not found to be statistically significant.

Child diet diversity, measured by the number of food groups consumed by a child in the previous 24 hours, is most significantly associated with the decreased probability of being stunted by 1.6 percentage point or severely stunted by 1.7 percentage point ($p < 0.01$).

In the basic specification of the model, the wealth of a household decreases the probability of a child being stunted by 2.4 percentage point ($p < 0.01$) with less significant effect for severe stunting.

Residing in rural areas, accessing agricultural land or residing in different agro-ecological areas do not show strong associations with child stunting. Share of expenditures on *qat* (a narcotic plant largely produced and consumed in Yemen) is also found to be not statistically significant. The log expenditure and the members of the households residing abroad (important for remittance payments) are also found to be not statistically significant.

When assets are added in the more complex specification of the model, access to improved drinking water sources is significant for a reduced incidence of stunting and severe stunting, decreasing the probability by 5 and 4.1 percentage points respectively ($p < 0.05$). Access to improved sanitation is also associated with a decreased probability of being stunted although significant only at 10 per cent for stunting. The only household asset that is significant for a reduced incidence of stunting and severe stunting is the access to an improved cooking stove, decreasing the probability by 5.1 and 4.1 percentage points respectively ($p < 0.05$). None of the other household assets (radio, TV, fridge and access to public electricity) was found to show significant associations with child stunting.

The 2013 UNICEF data set was analyzed separately because it included a number of health-based policy relevant indicators. Unfortunately the analysis did not provide robust results. Among the 6-23 months sub-sample, four variables appeared statistically significant in relation to stunting across a number of different specifications, namely female headed households, female child, low-birth weight of child as reported by the mother and number of Ante-Natal Care visits. The other variables included (whether the child was the first born, the number of food groups the child consumed in the last 24 hours, whether the mother delivered at a health facility, literacy of the mother, age of the mother when married, size of household, livestock, wealth index, open defecation, and treated drinking water at point of use) were not significant across any specification. This is likely due to the limitation of the sample used for the data set.

5.2.2 Variables associated with a child between 6 and 23 months being wasted and severely wasted

The analysis looks at the potential overlaps between risk factors associated with a child being stunted (and severely stunted) and a child being wasted (and severely wasted) without implying a direct causality but rather a bi-directional relationship. This is consistent with the growing evidence that both stunting and wasting are the result of multidimensional processes in which the child response is contingent on particular factors and circumstances (Khara et al. 2014). The aim is to identify relevant associations to inform a coherent policy and programmatic approach.

The table 16 reports the marginal effects of the Probit regressions for wasting and severe wasting on the same sub-sample of children between 6 and 23 months that was used for stunting and severe stunting. The models for stunting and wasting gave slightly different results although still consistent with the literature in Chapter 2 and with the descriptive analysis. McFadden's Pseudo R-squared is used as a measure of model fit. The values are between 0 and 1 and indicate that the model fit.

Similarly to stunting, girls are less likely to be wasted although this is statistically significant only at 10 per cent and not significant at all for severe wasting. While the probability of stunting increases with higher age, the reversed pattern is observed for wasting, with lower probability of wasting for older age groups. The analysis shows that the probability of being wasted decreases by 2.5 percentage points in the age group 12-17 months ($p<0.1$) and by 5.1 percentage points in the age group 18-23 months compared to the age group 6-11 months ($p<0.01$). The age is not statistically significant for severe wasting.

The number of children below 5 years of age per mother is positively associated with the probability of a child being severely wasted ($p<0.01$) but not for wasted alone, confirming that high fertility in the Yemeni context increases the risks of malnutrition among young children. Mother's MUAC, as a good predictor of mother's nutritional status, is highly associated to the probability of a child being wasted (6.9 percentage point; $p<0.01$) but not severely wasted.

Having experienced diarrhoea in the previous two weeks shows a statistically significant association with wasting. A child that has suffered from diarrhoea is 3.5 percentage points more likely to be wasted than a child that did not experience diarrhoea. The intake of vitamin A supplements does not seem to be associated with the incidence of diarrhoea or with a child being wasted or severely wasted.

Child diet diversity, measured by the number of food groups consumed by a child in the previous 24 hours, decreases the probability of a child being wasted by 1.2 percentage point ($p<0.01$) and of a child being severely wasted by 0.6 percentage point ($p<0.05$).

Of the household assets, owning a fridge decreases the probability of a child being wasted by 3.4 percentage point ($p<0.1$) while owning a radio decreases the probability of a child being wasted or severely wasted by 4.1 percentage point ($p<0.01$) and by 1.6 percentage point ($p<0.05$) respectively.

Table 16: Summary of the results from the Probit regression showing the most significant factors associated with stunting and severe stunting and with wasting and severe wasting in a sample of children between 6 and 23 months of age.

	Child Stunting		Child Severe Stunting		Child Wasting		Child Severe Wasting	
	Model 1 (basic)	Model 2 (advanced)	Model 3 (basic)	Model 4 (advanced)	Model 5 (basic)	Model 6 (advanced)	Model 7 (basic)	Model 8 (advanced)
Child gender (female compared to male)	-0.0749*** (0.016 ¹⁰)	-0.0791*** (0.017)	-0.0615*** (0.013)	-0.0693*** (0.013)	-0.0234* (0.012)	-0.0251** (0.012)	-0.0083 (0.007)	-0.0101 (0.007)
Child age in months (age group 12 - 17 compared to 6 - 11)	0.1349*** (0.019)	0.1378*** (0.019)	0.0807*** (0.014)	0.0806*** (0.014)	-0.0268* (0.015)	-0.0256* (0.016)	-0.0180** (0.009)	-0.0131 (0.008)
Child age in months (age group 18 - 23 compared to 6 - 11)	0.2269*** (0.022)	0.2298*** (0.023)	0.1606*** (0.018)	0.1639*** (0.019)	-0.0528*** (0.017)	-0.0512*** (0.017)	-0.0131 (0.010)	-0.0086 (0.010)
Child Vitamin A supplementation (received in the last 6 months)	-0.0092 (0.018)	-0.0037 (0.018)	0.0015 (0.014)	0.0042 (0.014)	-0.0028 (0.013)	-0.0029 (0.014)	0.01 (0.008)	0.0083 (0.008)
Child diarrhoea incidence (child had diarrhoea in last 2 weeks)	0.0112 (0.017)	0.0104 (0.017)	-0.0077 (0.013)	-0.0087 (0.014)	0.0353*** (0.013)	0.0351*** (0.013)	0.0142* (0.007)	0.0122* (0.007)
Child diet diversity (no. of food groups child consumed last 24 hrs)	-0.0177*** (0.006)	-0.0166*** (0.006)	-0.0177*** (0.005)	-0.0177*** (0.005)	-0.0136*** (0.005)	-0.0125*** (0.005)	-0.0067** (0.003)	-0.0065** (0.003)
Birth spacing (no. of children <5yrs old per mother)	0.0506*** (0.013)	0.0518*** (0.013)	0.0408*** (0.010)	0.0413*** (0.010)	0.014 (0.010)	0.0131 (0.010)	0.0164*** (0.005)	0.0181*** (0.005)
Maternal nutrition status (mother's MUAC)	-0.0068*** (0.002)	-0.0067*** (0.002)	-0.0067*** (0.002)	-0.0066*** (0.002)	-0.0066*** (0.002)	-0.0069*** (0.002)	-0.0002 (0.001)	-0.0006 (0.001)
Maternal education (spouse illiterate)	0.0283 (0.019)	0.0286 (0.020)	0.0219 (0.016)	0.0179 (0.016)	0.0097 (0.015)	0.0088 (0.015)	-0.0069 (0.008)	-0.0068 (0.008)
Household head gender (female compared to male)	0.0980** (0.041)	0.1177*** (0.043)	0.0142 (0.033)	0.0079 (0.034)	-0.0078 (0.030)	-0.0013 (0.032)	0.0053 (0.016)	0.0071 (0.017)
Household head education (household head illiterate)	0.0072 (0.021)	0.0021 (0.022)	0.0184 (0.016)	0.0129 (0.017)	0.0018 (0.016)	0.0014 (0.016)	0.0003 (0.009)	-0.0003 (0.008)
Household head age (age at the time of the survey)	0.0007 (0.001)	0.0008 (0.001)	-0.0005 (0.001)	-0.0004 (0.001)	-0.0005 (0.001)	-0.0005 (0.001)	0.0002 (0.000)	0.0003 (0.000)
Household size (number of household members)	-0.0027 (0.002)	-0.0027 (0.002)	-0.0005 (0.002)	-0.0006 (0.002)	0.0018 (0.002)	0.0019 (0.002)	0.0004 (0.001)	0.0004 (0.001)
Household location (dummy 1 for rural residence)	0.0352 (0.027)	-0.0107 (0.027)	0.0222 (0.021)	-0.0223 (0.022)	-0.0011 (0.021)	-0.0221 (0.021)	0.0081 (0.013)	-0.0161 (0.012)

¹⁰ The figure between brackets represents the clustered error at the household level

Table 16: Summary of the results from the Probit regression showing the most significant factors associated with stunting and severe stunting and with wasting and severe wasting in a sample of children between 6 and 23 months of age.

	Child Stunting		Child Severe Stunting		Child Wasting		Child Severe Wasting	
	Model 1 (basic)	Model 2 (advanced)	Model 3 (basic)	Model 4 (advanced)	Model 5 (basic)	Model 6 (advanced)	Model 7 (basic)	Model 8 (advanced)
Household expenditure on qat (share of expenditures on qat)	0.0009 (0.001)	0.0007 (0.001)	0.0006 (0.001)	0.0006 (0.001)	-0.0005 (0.001)	-0.0005 (0.001)	-0.0004 (0.000)	-0.0005 (0.000)
Household access to land (dummy 1 if household has access)	0.0007 (0.020)	0.0011 (0.020)	-0.0094 (0.016)	-0.0065 (0.016)	0.0065 (0.015)	0.0094 (0.015)	0.006 (0.008)	0.0073 (0.008)
Agro-ecological area: Red Sea & Tihama coast (compared to Temperate Highlands)	-0.009 (0.054)	0.0144 (0.058)	0.0165 (0.040)	0.0137 (0.042)	0.0605 (0.051)	0.045 (0.051)	0.0252 (0.027)	0.0295 (0.029)
Agro-ecological area: Arabian Sea (compared to Temperate Highlands)	-0.0214 (0.050)	-0.0071 (0.051)	0.0261 (0.043)	0.0318 (0.044)	0.1000** (0.046)	0.0987** (0.045)	0.0087 (0.024)	0.0089 (0.024)
Agro-ecological area: Internal Plateau (compared to Temperate Highlands)	0.0305 (0.052)	0.0387 (0.052)	0.0606 (0.046)	0.0631 (0.046)	-0.0085 (0.042)	-0.0138 (0.041)	-0.0189 (0.021)	-0.0215 (0.020)
Agro-ecological area: Desert (compared to Temperate Highlands)	0.0775 (0.070)	0.0802 (0.070)	0.1166* (0.072)	0.1205* (0.072)	-0.0673 (0.042)	-0.0609 (0.043)	-0.0352 (0.020)	-0.0346 (0.020)
Agro-ecological area: Dry Highland (compared to Temperate Highlands)	-0.011 (0.029)	-0.0077 (0.030)	0.0225 (0.022)	0.0206 (0.022)	-0.0358* (0.022)	-0.0305 (0.022)	-0.0158 (0.013)	-0.0157 (0.014)
Household wealth index (Urban and Rural combined)	-0.0249*** (0.009)		-0.0189** (0.007)		-0.0167** (0.007)		-0.0134*** (0.004)	
Household expenditure per capita (log expenditure)		0.001 (0.013)		-0.0032 (0.010)		-0.0112 (0.010)		0.0018 (0.005)
Household access to sanitation facility (improved sanitation facility)		-0.0421* (0.023)		-0.0362** (0.018)		-0.0313* (0.017)		-0.0195** (0.009)
Household access to source for lighting (public electricity)		0.0168 (0.021)		0.0041 (0.016)		0.0351** (0.016)		-0.0059 (0.009)
Household access to drinking water source (improved water source)		-0.0508** (0.021)		-0.0417** (0.016)		0.01 (0.016)		0.0087 (0.008)
Household owns a cooking stove (LPG or kerosene stove)		-0.0511** (0.024)		-0.0413** (0.020)		0.0027 (0.019)		-0.0349*** (0.012)
Household owns a radio		-0.0274 (0.018)		-0.0126 (0.014)		-0.0417*** (0.014)		-0.0160** (0.008)
Household owns a TV		0.0144 (0.022)		0.0078 (0.017)		-0.0039 (0.016)		0.0066 (0.009)

Table 16: Summary of the results from the Probit regression showing the most significant factors associated with stunting and severe stunting and with wasting and severe wasting in a sample of children between 6 and 23 months of age.

	Child Stunting		Child Severe Stunting		Child Wasting		Child Severe Wasting	
	Model 1 (basic)	Model 2 (advanced)	Model 3 (basic)	Model 4 (advanced)	Model 5 (basic)	Model 6 (advanced)	Model 7 (basic)	Model 8 (advanced)
Household owns a fridge		-0.0272 (0.023)		-0.0121 (0.019)		-0.0343* (0.018)		-0.0144 (0.010)
Household has a share of workers abroad		-0.0006 (0.000)		-0.0002 (0.000)		-0.0004 (0.000)		-0.0002 (0.000)
Governorate Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	3,144	3,052	3,144	3,052	3,133	3,042	3,133	3,042
Pseudo R squared	0.1053	0.1102	0.1056	0.1123	0.0615	0.071	0.0939	0.1076

* p<0.1, ** p<0.05, *** p<0.01

5.2.3 Variables associated with diet diversity among children between 6 and 23 months old

Child diet diversity is most significantly associated with the decreased probability of being stunted, severely stunted, wasted and severely wasted ($p < 0.01$). This variable is further analyzed to identify factors that could be relevant for policy makers across key sectors.

The table 17 reports the results for two dependent variables: 1) the number of food groups consumed by the child in the 24 hours preceding the interview and, 2) the consumption of animal-based sources by the child in the 24 hours preceding the interview. All variables report the marginal effects from the Poisson regression. The regression diagnostics suggest that for both dependent variables the Poisson model agrees with Pearson's test for goodness of fit. The model fits reasonably if the Pearson goodness-of-fit test is not statistically significant.

Child gender is not significant in terms of diet diversity. This is consistent with the findings from the descriptive analysis. However child age from 12 to 17 months and for 18 to 23 months is statistically significant for greater diet diversity when compared to younger children in the 6 to 11 months category. Being in the age group 12-17 months and in the age group 18-23 months increases the number of food groups consumed by 0.6811 and 0.8419 respectively ($p < 0.01$). This is not surprising as it is common practice for older children to consume more food products. These results are consistent with the findings from the descriptive analysis.

Among household characteristics, only two variables show significant relationship with child diet diversity. Household size positively impacts on the number of food items consumed by young children ($p < 0.05$). In terms of education, the fact that the spouse is illiterate, is strongly associated to diet diversity. Being illiterate reduces the number of food groups consumed by a child by 0.2014 ($p < 0.01$). An illiterate spouse has a child consuming 1.85 food groups compared to 2.05 food groups for a literate spouse. Being a female household head and residing in rural areas are not statistically associated to child diet diversity. The household size appears to be statistically associated with diet diversity (0.0178; $p < 0.05$)

Among assets, the two items statistically related to child diet diversity are the ownership of a fridge and the ownership of an improved cooking stove (LPG or kerosene). Owning a fridge or an improved stove increases the number of food groups consumed by a child by 0.296 points ($p < 0.01$) and by 0.1916 points ($p < 0.01$) respectively. Access to improved drinking water sources, improved sanitation or public electricity do not appear to be strongly associated to child diet diversity.

The expenditure per capita (log), widely used as a proxy for the household welfare status, shows a significant and positive association with diet diversity (0.3841; $p < 0.01$). Among all shocks reported by households in the previous six months, the most significant are those related to high health expenditures, high food prices, high debt to repay, reduced remittances or wages, or loss of employment. All have a considerable negative effect on child diet diversity. High health expenditure for instance, reduces the number of food groups by 0.3805, which corresponds to 18.5 per cent of the mean ($p < 0.01$). Similarly, decreased remittances or wages

or loss of employment reduce the number of food groups by 0.3154 ($p < 0.01$). Experiencing high food prices or high debt to repay has a similar impact on the number of food groups consumed by the child (-0.2046 and -0.2376 respectively; $p < 0.01$).

In terms of agro-ecological areas only the Red Sea and Tihama coast perform better in diet diversity compared to the Temperate Highlands (base category), with a positive, significant and large coefficient. Residing on the Red Sea and Tihama coast increases by 0.5 the number of food groups consumed, which corresponds to 25 per cent ($P < 0.01$). The Dry Highlands are negatively related to child diet diversity compared to the Temperate Highlands (-1.867; $p < 0.05$).

When looking at the livelihood strategies, agriculture/livestock/fishery, which are used as the base category, outperform all other types of livelihood sources, which have been categorized into six main groups (regular salary, wage labour/drivers, private business, wood/petty trade, remittances/social-welfare/pension, *qat*). The strongest association appears to be for the consumption of animal-protein food groups: sources of livelihoods derived from agriculture, livestock and fishery ensure a higher number of animal-protein foods in the child diet. The difference is most significant for sources of livelihoods from wage labour/driver and from remittances or social welfare or pension, which are negatively related to the number of animal-protein food groups consumed by the child (-0.1768 and -0.1897 respectively; $p < 0.01$). The share of household workers abroad is positive and statistically significant only for the regression assessing the total number of food groups consumed by a child and with a small coefficient (0.0030; $p < 0.01$). Neither the share of expenditure on *qat* nor the *qat* as the main source of income show any statistically significant relationship with the number of food groups or with the number of animal-protein sources consumed by a child.

The same regression was run on a larger sample, including children from 6 to 59 months. The results are consistent, with some variables showing even stronger statistical significance in the model with bigger sample.

Separately, the analysis on the children from 6-59 months was restricted to those households who had access to land in 2011. In addition to the covariates included in the previous models, selected agricultural specific variables - livestock ownership, size of agriculture land and access to irrigation - were added. None of the selected agricultural specific variables show a statistically significant association with the number of food groups or with the animal-protein sources consumed by a child. Some differences were found compared to the main model. The literacy of the spouse was no longer statistically significant, among shocks now only the lack of rain was significant, as well as high health expenses. Radio and TV were now positively associated to increases in number of food groups consumed, with ownership of a fridge or an improved cooking source being significant as with the main model.

Table 17: Summary of the results from the Poisson regression showing the most significant factors associated with child diet diversity and with access to animal-protein food sources among children between 6 and 23 months of age, Yemen 2011

	No. animal protein food child consumed		No. food groups child consumed	
	Model 1 (basic)	Model 2 (advanced)	Model 3 (basic)	Model 4 (advanced)
Child gender (female compared to male)	0.0103 (0.027 ¹¹)	0.0057 (0.027)	0.0202 (0.047)	0.0146 (0.048)
Child age in months (age group 12 - 17 compared to 6 - 11)	0.1996*** (0.031)	0.1984*** (0.031)	0.6736*** (0.053)	0.6811*** (0.054)
Child age in months (age group 18 - 23 compared to 6 - 11)	0.2738*** (0.036)	0.2809*** (0.037)	0.8243*** (0.063)	0.8419*** (0.063)
Birth spacing (no. of children <5yrs old per mother)	-0.009 (0.022)	-0.0058 (0.022)	0.0182 (0.038)	0.0226 (0.038)
Household head gender (female compared to male)	-0.0383 (0.080)	-0.0557 (0.085)	-0.0808 (0.127)	-0.1358 (0.135)
Household head education (household head illiterate)	-0.0267 (0.040)	-0.0184 (0.041)	-0.0199 (0.067)	-0.0101 (0.069)
Maternal education (spouse illiterate)	-0.0959*** (0.033)	-0.1003*** (0.034)	-0.1887*** (0.057)	-0.2014*** (0.058)
Household head age (age at the time of the survey)	-0.0005 (0.002)	-0.0002 (0.002)	0.0012 (0.003)	0.0017 (0.003)
Household size (number of household members)	0.0121*** (0.004)	0.0101** (0.004)	0.0220*** (0.007)	0.0178** (0.007)
Household location (dummy 1 for rural residence)	0.0017 (0.039)	-0.0175 (0.039)	-0.0609 (0.070)	-0.0805 (0.070)
Household expenditure on qat (share of expenditures on qat)	-0.0016 (0.001)	-0.0019 (0.001)	-0.0022 (0.002)	-0.0023 (0.002)
Agro-ecological area: Red Sea & Tihama coast (compared to Temperate Highlands)	0.2762** (0.118)	0.2322** (0.121)	0.5491*** (0.198)	0.4985** (0.216)
Agro-ecological area: Arabian Sea (compared to Temperate Highlands)	-0.0612 (0.081)	-0.075 (0.083)	-0.0216 (0.152)	-0.0498 (0.154)
Agro-ecological area: Internal Plateau (compared to Temperate Highlands)	-0.1135 (0.080)	-0.1460* (0.080)	-0.0194 (0.154)	-0.1015 (0.153)
Agro-ecological area: Desert (compared to Temperate Highlands)	0.0054 (0.122)	-0.0186 (0.121)	-0.2715 (0.169)	-0.284 (0.172)
Agro-ecological area: Dry Highland (compared to Temperate Highlands)	-0.1407*** (0.054)	-0.1501*** (0.055)	-0.1673* (0.095)	-0.1867** (0.097)
Household expenditure per capita (log expenditure)	0.2259*** (0.023)	0.2270*** (0.024)	0.3816*** (0.041)	0.3841*** (0.043)
Household shock (high health expenditure)	-0.2084*** (0.052)	-0.2094*** (0.052)	-0.3981*** (0.084)	-0.3805*** (0.085)
Household shock (high food prices)	-0.0626 (0.047)	-0.049 (0.049)	-0.2339*** (0.087)	-0.2046** (0.089)
Household shock (high debt to repay)	-0.1431*** (0.040)	-0.1323*** (0.040)	-0.2534*** (0.066)	-0.2376*** (0.067)
Household shock (reduced remittances/wages, loss employment)	-0.1532***	-0.1535***	-0.3265***	-0.3154***

¹¹ The figure between the brackets represents the clustered error at household level

Table 17: Summary of the results from the Poisson regression showing the most significant factors associated with child diet diversity and with access to animal-protein food sources among children between 6 and 23 months of age, Yemen 2011

	No. animal protein food child consumed		No. food groups child consumed	
	Model 1 (basic)	Model 2 (advanced)	Model 3 (basic)	Model 4 (advanced)
	(0.047)	(0.047)	(0.078)	(0.079)
Household shock (lack/late rain)	-0.0493	-0.0553	-0.1338	-0.1497*
	(0.051)	(0.052)	(0.086)	(0.087)
Household shock (insecurity/violence)	-0.0504	-0.0544	-0.0582	-0.0509
	(0.041)	(0.042)	(0.069)	(0.070)
Household shock (death of HH member)	-0.0196	0.0017	0.0498	0.0474
	(0.134)	(0.143)	(0.210)	(0.221)
Household access to sanitation facility (improved)	0.005	-0.0024	0.077	0.0621
	(0.045)	(0.046)	(0.073)	(0.073)
Household access to drinking water source (improved)	0.0277	0.0253	-0.0017	0.0071
	(0.035)	(0.035)	(0.062)	(0.063)
Household access to source for lighting (public electricity)	-0.0203	-0.0282	0.0097	-0.013
	(0.037)	(0.038)	(0.062)	(0.063)
Household owns a radio	0.0057	0.0149	-0.0052	0.0135
	(0.030)	(0.030)	(0.052)	(0.053)
Household owns a TV	-0.017	-0.0224	0.0332	0.0309
	(0.042)	(0.043)	(0.067)	(0.069)
Household owns a cooking stove (LPG/kerosene)	0.1528***	0.1535***	0.2163***	0.1916***
	(0.041)	(0.041)	(0.068)	(0.068)
Household owns a fridge	0.1524***	0.1518***	0.3051***	0.2962***
	(0.039)	(0.040)	(0.068)	(0.069)
Household has a share of workers abroad		0.001		0.0030***
		(0.001)		(0.001)
Household livelihoods: qat (compared to agric./fish./liv.)		-0.0877		-0.0924
		(0.088)		(0.152)
Household livelihood: wood/petty trade (compared to agric./fish./liv.)		-0.1970*		-0.2489
		(0.098)		(0.177)
Household livelihood: sales (compared to agric./fish./liv.)		-0.1395**		-0.1529
		(0.068)		(0.118)
Household livelihood: non-gov. wage /driver (compared to agric./fish./liv.)		-0.1768***		-0.2116*
		(0.068)		(0.117)
Household livelihood: gov. salary (compared to agric./fish./liv.)		-0.1372**		-0.1616
		(0.065)		(0.113)
Household livelihood: remittances/Social Welfare Fund/pension (compared to agric./fish./liv.)		-0.1897***		-0.2382*
		(0.073)		(0.131)
Governorate fixed effects	Yes	Yes	Yes	Yes
Pearson goodness-of-fit test	2598	2506	3026	2927
--- p-value	1	1	1	1
Number of Observations	3,397	3,297	3,397	3297
Adjusted R squared	0.064	0.0645	0.0679	0.0683

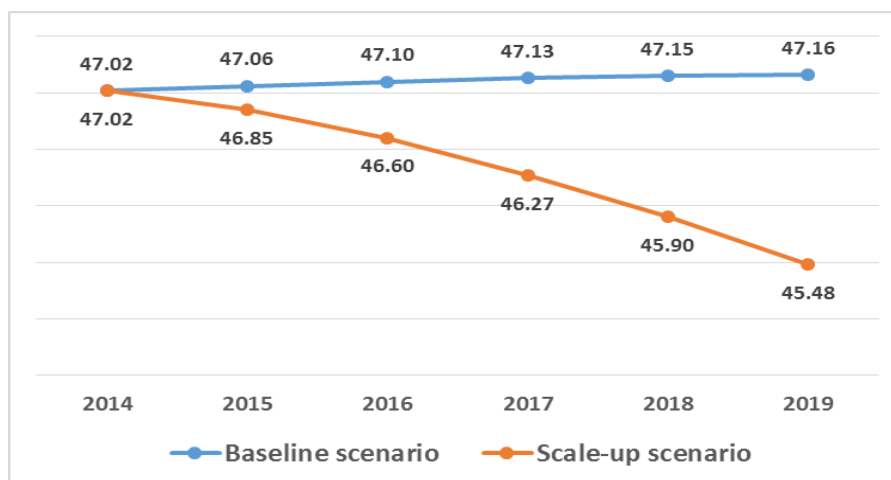
* p<0.1, ** p<0.05, *** p<0.01

5.2.4 Results from simulations to predict outcomes

5.2.4.1 Results from the LiST model

If no nutrition specific interventions are scaled up, there will be an increase in the prevalence of stunting among children less than five years of age by 0.14% to 47.16% by year 2019. Instead, if the scale-up scenario is applied, there will be an overall fall of 1.54% to 45.48 % by year 2019.

Figure 19: Predicted changes in child stunting prevalence using the LiST model to compare a baseline scenario and a scale-up scenario, Yemen 2014-2019



By scaling up the interventions, the age group that would benefit the most would be 6-23 months with a reduction by 1.92% for the 6-11 months children and 2.49% for the 12-23 months. The reduction for the age group 24-59 months would be less at 1.59%.

The baseline scenario assumes that the existing interventions are maintained at the current coverage level. The total cost over five years would be around USD 118 million (approximately 24 million a year). Table 18 shows that there would be an increase in the number of stunted children showing that a no-change scenario would indeed result in cost inefficiency for each USD 1 million currently spent.

By applying the scale-up scenario to a limited set of high-impact interventions, the total cost over five years would be around USD 373.5 million, almost three times the baseline scenario. Scaling up the coverage of interventions would result in 182 cases averted per USD 1 million invested as shown in Table 19.

Table 18: Estimated costs for the baseline scenario and under the scale-up scenario, Yemen 2014-2019

Scenarios	Total Cost of Expansion, by Year (USD '000)					Total Cost (USD)
	2015	2016	2017	2018	2019	
Baseline	23,955	23,955	23,955	23,955	22,124	117,943
Scale up	54,518	64,633	74,747	84,853	94,695	373,446

Source: Maximizing the Quality of Scaling Up Nutrition (2014)

Table 19: Cost effectiveness of the scale-up scenario compared to the baseline scenario, Yemen 2014-2019

Scenarios	Number of stunted children under 5		Changes in number of stunted children	Cost effectiveness
	2014	2019		
Baseline	2,074,214	2,080,390	+ 6,176	
Scale-up	2,074,214	2,006,280	- 67,935	182

Source: Maximizing the Quality of Scaling Up Nutrition (2014)

5.2.4.2 Results from adding variables to the LiST model

The relatively modest decline in stunting levels observed by using the LiST module is due to limitations in the included interventions but also to the coverage levels established by each ministry. The cost estimation and the establishment of projected coverage levels were determined against a very low per capita social spending, low overseas development assistance and considerable competing demands with financing for nutrition previously untried.

The trajectory analysis is performed on the age group 6-23 months using the estimated coefficients. Using the estimated coefficients the predicted prevalence of stunting is 38.1% versus the actual stunting prevalence of 39.7%.

The factors that are selected for the trajectory analysis are: the number of children below 5 years per mother (proxy for birth spacing), number of food groups the child consumed in the previous 24 hours (proxy for child minimum diet diversity), proportion of illiteracy among spouses (proxy for maternal education) and access to improved drinking water sources. Each of these factor has significance from a policy perspective. The table 19 presents 4 scenarios, the first assuming the current (2011) levels of the variables, the second modifies the determinants at levels that would decrease the stunting prevalence to 35%, the third to 30%, the fourth to 25%.

Table 20: Required changes of the levels of four key factors to reach the stunting target of 25% among children between 6 and 23 months of age, Yemen 2014-2019

Factors	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	2011 situation	Stunting - 35% target	Stunting - 30% target	Stunting - 25% target
Birth spacing (no. <5yrs children per mother)	1.6	1.4	1.1	1
Maternal education (% of illiterate spouse)	61	50	30	5
Drinking water supply (% of households accessing improved supply)	35	50	70	98
Child minimum diet diversity (no. of food groups a child between 6 and 23 months of age consumed in the last 24 hours)	2.1	2.5	3	4.5
Predicted stunting prevalence	38.1%	35.1%	30.8%	25.7%

Source of baseline scenario: Comprehensive Food Security Survey (2011)

It should be noted that the simulations assume no changes in the mean value and in the relationships among the different covariates. It is likely that the current crises in Yemen will exacerbate the household vulnerability to shocks, disrupt the services and put some of the positive changes on halt, especially with regards to the women situation.

5.3 Third research objective: results from the decision making process

5.3.1 Results from the consultation process among key decision-makers

The findings from the descriptive and quantitative analysis were summarized into a matrix (Annex 4) and discussed with key stakeholders from Government sectors, United Nations Agencies and Non-Government Organizations. These findings were combined with contextual qualitative observations to establish a hierarchy of evidence to inform decision-making about the mix of public interventions to be included in the national strategic framework. The process included a number of internal consultations among sectoral stakeholders to familiarize themselves with the findings from the analysis as well as the process required for further planning and costing of the multi-sector plan.

The internal consultations culminated with one workshop conducted in May 2014 that was attended by twenty decision-makers from the co-ordinating Ministry of Planning and International Cooperation, Ministry of Health and Population, Ministry of Agriculture and Irrigation, Ministry of Fisheries Wealth, Ministry of Water and Environment and the Ministry of Education. There was no ministerial participation from two key players, the Ministry of Social

Affairs and Labour and the Ministry of Finance. The workshop also included senior advisors from development partners responsible to provide technical and financial assistance. The workshop was held in English with Arabic translation when requested.

The participants from each sector were asked to review their existing ministerial plans through a 'nutrition outcome lens' in order to consider how their interventions would impact on child stunting and associated determinants. Participants were asked to categorize their identified interventions as:

- 'Core interventions' if they directly target young children (0-23 months) and pregnant and lactating women.
- 'Expanded core interventions' if they target women of reproductive age, in particular adolescent girls, or households with pregnant and lactating women in order to address key determinants of child stunting. 'Core' and 'expanded core' interventions are characterized by a very high convergence through targeting.
- 'Contributing interventions' if they target vulnerable groups or communities that share contextual determinants significantly associated with the nutritional well-being of the individuals most at risk of stunting (e.g. same livelihoods).

Participants were asked to triangulate all the evidence, qualitative and quantitative, along with their experiential perspectives, to allow the final choices for the 'mix of interventions' to be undertaken. This triangulation was done in group works and the findings were summarized under key issues for discussion in plenary.

The prioritization and sequencing of interventions was done at the same time of the cost estimation at ministerial level. Scaling up projections and unit costs were established by each ministry with guidance from technical and financial experts. The entire costing process was completed in the beginning of 2015 prior the escalation of the current crisis.

5.3.1.1 Demographic targeting: who are the children at highest risk of becoming stunted?

The information derived from the descriptive and quantitative analysis was used in order to guide the prioritization in terms of population targeting. Given that the aim is to prevent a child from becoming stunting and therefore reduce the prevalence of child stunting in Yemen, the findings from the analysis reinforced the argument about the need to focus on the young children, especially those between 6-23 months.

The analysis showed that children from malnourished women have a highest probability of becoming stunting. Results also indicated that the main share of severe malnourished women is in the age group 15-19 years.

While it is well acknowledged that the prevalence of child stunting is higher among rural population, the quantitative analysis showed that residing in rural areas is not a statistically significant predictor of child stunting in the presence of other household characteristics related to demography, livelihoods and access to specific assets.

The analysis showed the highest predisposition of a male child in the age group 6-23 months to be stunted and, to a less extent, wasted. The increased risk of growth faltering among male children was not found to be associated to any difference in feeding behaviours as observed from the descriptive and quantitative findings.

5.3.1.2 Geographic targeting: where do most of the children at risk of becoming stunted live?

For the geographical segmentation, the planning team used the prevalence of child stunting and child wasting and the level of household poverty and food insecurity. Coverage of key services was further discussed to prioritize actions and approaches by sector.

More than half of the governorates (12 out of 22) present levels of stunting of 40% or more. However, 50% of all stunted children in Yemen live in 69 out of 333 districts. The number of district doubles to 140 districts when considering 75% of all stunted children in Yemen. Less than half of the governorates (10 out of 22) present levels of wasting of 10% or higher. Half of all wasted children in Yemen live in 50 out of 333 districts (75% live in 117 districts). Considering a 50% or a 75% coverage has considerable operational and financial implications.

The identification of overlaps between child stunting and child wasting with household food insecurity and poverty levels is useful at national level to identify high-risk areas. However, a more in-depth segmentation would need to be repeated at sub-national level to identify the nutritionally vulnerable communities and households.

5.2.1.3 Priority actions and approaches by each sector

Each Ministry was asked during the workshop to re-examine their interventions through a nutrition lens. Participants worked in groups to prioritize interventions in their plans by clearly articulating the links to nutrition outcomes. During the plenary discussions, participants were asked how the selected interventions would be coordinated between ministerial sectors to optimize the use of human and financial resources.

The group work showed that the articulation of the direct or indirect link of an intervention to nutrition outcomes, requires adjustments at target level, specifically towards nutrition vulnerable groups, or at input level. The changing of targets and/or of inputs does have operational and financial implications, which ultimately can affect the decision making process.

5.2.1.3.1 The role of the health sector

Addressing birth outcomes

The analysis showed that the unmet needs for family planning are highest among the rural and uneducated young married women and that the emphasis is on birth spacing rather than parity, particularly among women below 30 years. The Ministry of Health and Population included family planning among the 'expanded core' interventions.

Ante-Natal Care (ANC) was prioritized as a 'core intervention' because of the opportunity to use the service for two nutrition specific interventions namely micronutrient supplementation and nutrition rehabilitation of acutely malnourished pregnant women.

Addressing complementary feeding practices for children 6-23 months

Ante-Natal Care (ANC) and safe delivery were identified as the two main entry points for counselling on appropriate age-based child feeding practices. The analysis showed that the rural and uneducated mothers were significantly less likely to access ANC and safe delivery. However, the analysis also showed that women, who delivered in the health facilities, were significantly less likely to initiate early breastfeeding than those delivering at home. This prompted a discussion on the actual quality of nutrition counselling provided by the trained practitioners in Yemen.

Given the low reach of institutional services, community delivery systems were identified as the most viable alternative for educating mothers on appropriate age-based child feeding practices as well as for detecting severely or moderately malnourished children and referring them to nutrition rehabilitation services.

Addressing the incidence of diarrhoea and the exposure to environmental enteric dysfunction.

Optimal breastfeeding of young children was included as one of the nutrition-specific interventions that reduces the risk of diarrhoea and acute malnutrition. Management of diarrhoea through the provision of ORS and Zinc was also prioritized together with continued supplementation of Vitamin A.

The analysis showed that the children with the highest risk of diarrhoea and also of wasting are those in the age group 6-23 months followed by the age group 0-5 months.

Considerations on scale and coverage of selected interventions

In terms of scale, it was agreed that priority for the selected interventions should be given to the 50 districts with the highest concentration of stunted and wasted children.

For the most impactful coverage of the child nutrition interventions, the priority age group is the one between 6 and 23 months. However, infants below six months should also be prioritized in Yemen because of the significant prevalence of low-birth weight, inappropriate breastfeeding practices, acute malnutrition and diarrhoea within this age group.

Going to scale with maternal core nutrition interventions like IFA or micronutrient supplementation or provision of food supplements requires to piggy back on existing ANC services in order to optimize the contact points with pregnant women.

All selected interventions were already in the plan of the Ministry of Health and Population. The final consultation, however, highlighted the need to narrow the scope of the community-based

health delivery systems to prioritize the needs of pregnant and lactating women and of young children in order to get better nutrition outcomes.

5.2.1.3.2 The role of the WASH sector

Addressing the incidence of diarrhoea and the exposure to environmental enteric dysfunction.

The Ministry of Water & Environment recognized the importance of increasing access to improved drinking water sources and sanitation facilities in order to prevent stunting among children. The analysis also showed that the lack of improved sanitation facilities increases the probability of a child being wasted.

Three interventions were prioritized in the group work in order to improve the coverage of drinking water sources: rehabilitation of non-functional drinking water supply systems, protection of drinking water sources at community level and provision of support for the construction of rainwater harvesting facilities at community and household level.

Changing hygiene behaviours was identified as one of the greatest challenges and recommendations were made to scale-up campaigns with a sustained duration. A combination of media and community-based approaches was identified as the most feasible way-forward with priority to be given to the promotion of hand-washing and hygienic practices. Construction of improved sanitation facilities at household level was deemed beyond the public sector investment.

Considerations on scale and coverage of selected interventions

In terms of scale, it was agreed that priority should be given to around 50 districts with the highest concentration of stunted and wasted children.

For the most impactful coverage of the child nutrition interventions, it was emphasized that young children, who are exposed to diarrhoea and acute malnutrition, are at highest risk of mortality and should therefore be prioritized in getting access to a supply of safe drinking water. Participants agreed that all health facilities should be targeted for construction or maintenance works in terms of water supply systems and improved sanitation facilities. In addition, households with children, who are undergoing malnutrition treatment, should be provided by the health workers with chlorine tablets to treat the drinking water at point of use.

Schools were identified as the most impactful entry point for the promotion of hand-washing and hygienic practices with the students playing a significant role as agents of community change. All schools were prioritized for construction or maintenance works in terms of water supply systems and improved sanitation facilities. Schools were also seen as the ideal platform to engage the parents in a dialogue on improved sanitation facilities and hygiene practices at household level. Given the current low coverage, construction of sanitation facilities was seen as an intervention to be sequenced after sustained hand-washing and hygiene campaigns.

Interventions requiring construction and maintenance works of drinking water systems were already included in the plan of the Ministry of Water & Environment. The plenary session with the other ministries, however, provided a strong case on why health facilities and schools should be prioritized above other public facilities, not least because of their potential to increase effective coverage of vulnerable populations, namely women and children. Participants in the workshop all agreed that this was an example where additional investments with a focus on behaviour changes could leverage large-scale capital and maintenance costs to achieve better nutrition outcomes.

5.2.1.3.3 The role of the education sector

Education, in particular ensuring that girls complete their primary and preferably also their secondary education, is expected to contribute to the nutrition wellbeing of future generations. Data shows that highest level of maternal education is significantly associated to child stunting prevalence decreases and increased access to maternal health care services. Educated mothers are most likely to visit a health facility or health provider if the child is sick with diarrhoea although how the child is treated for diarrhoea does not change with the level of maternal education. The regression analysis also showed that high maternal education increased child dietary diversity, which is one of the key predictor of reduced child stunting and child wasting.

Recognizing the importance of female education, the Ministry of Education in Yemen was already committed to improve the coverage and quality of education services targeted to girls. The recruitment of female teachers and the construction of gender separate class rooms and gender separate improved sanitation facilities were all essential elements already included in the sectoral plan with a focus on increasing the retention of girls after they reach adolescence.

Access to schools that are suitable to girls' attendance was only seen as one way to address the cultural barriers to female education. Participants in the work groups discussed the domestic responsibilities of girls in rural households that range from collecting water and fire wood to taking care of the younger children. Household conditional food or cash transfers linked to girls' education were discussed as one potential response to socio economic barriers and as one way to introduce the gender discussion in the community.

Addressing birth outcomes

Women who attended school are half as likely to get married early and to have a pregnancy by age 15 or by age 18. Hence, keeping girls in school is considered as the most effective way to prevent early pregnancy. This is especially relevant in Yemen given that there are almost no births outside the wedlock.

Schools were identified as the main entry point to reach adolescent girls either directly or indirectly through peer-to-peer mechanisms. Identified nutrition-specific core interventions included folic acid supplementation, provision of fortified school snacks and nutrition education with a focus on healthy dietary habits. There was also a discussion on how to create a system

for early identification of severely malnourished adolescent girls and referral to the nutrition rehabilitation programs.

Considerations on scale and coverage of selected interventions

In terms of scale, it was agreed that, out of the 50 districts, priority should be given to those districts that have the widest gender school enrolment gap.

For the most impactful coverage, it was emphasized that girls are at highest risk of dropping out of school when they reach puberty. This means that material support and conditional food or cash transfers would need to be tailored to the age group 11-18 years if the aim is to increase school retention as a way of preventing early marriage and pregnancy.

The provision of fortified food snacks is meant to improve the micro-nutrition status of adolescent girls, especially to increase their level of iron. The supplementation of folic acid is directly aimed at protecting the new-born from the occurrence of spina bifida. During the plenary consultation, many questions were raised on the potential impact of both interventions in terms of birth outcomes and child stunting given that most girls likely to give births by 15 or by 18 would be those that have dropped out from schools.

Schools were also identified as the best platform for the promotion of healthy dietary habits among students. The inclusion of nutrition education was seen as an integral part of the ongoing efforts to upgrade the school curriculum rather than as a separate intervention.

Schools' construction and maintenance as well as teachers' recruitment were already included in the plan of the Ministry of Education. The final consultation, however, provided a strong case on why improvement of infrastructure and teacher availability should be tailored towards increasing the retention of girls beyond age eleven. This was seen as an example where additional investments, mostly by development partners and with a focus on conditional food or cash transfers, could leverage large-scale capital and maintenance costs to potentially achieve better nutrition outcomes through increased female education. In terms of risks, it was noted that compensation mechanisms for male students would need to be devised in order to foster the community acceptance of girls' education, which is paramount to remove cultural and socio-economic barriers.

5.2.1.3.4 The role of the agriculture and fishery sector

The group work by the Ministry of Agriculture and Irrigation and by the Ministry of Fishery Wealth required several iterations in order to select those interventions that could be directly or indirectly linked to child and women dietary diversity. The most significant shift in the participants' point of view was a better understanding of the distinctive attributes that constitute nutrition security of vulnerable groups and, within those, of young children and women. The analysis clearly showed that households from livelihoods that derive their main income from agriculture, fishery and livestock are those less likely to have stunted children. In

other words, while they might be vulnerable in terms of food security, they perform better than the other livelihoods when it comes to nutrition security.

Given the primary focus of the agriculture sector on smallholders, significant discussion took place around household level production and direct consumption of diversified foods. It was noted that 30% of the available water is used for the production of *chat* but, because of its high demand, no alternative options have been implemented at scale. Off-setting *chat* with nutritious crops such as pulses, fruits and vegetables would only be viable if there is a significant change in the consumers' dietary patterns. According to the experts, nutritious foods were available in the local market but not accessible because of the high prices. Post-harvest losses and transport costs were seen as main barriers to the price reduction.

Fishery is one of the main income source in Yemen but is almost exclusively for export. According to the experts, fish and fish-based products are not available in the domestic market and the demand is low even in coastal areas. The discussion focused on how to increase the domestic supply of nutrient-rich fishes such as sardines and mackerels, which are currently discarded because of no export demand. It was noted that this approach would be most attractive to small-scale fish enterprises and could be included as a pro-poor measure. This type of shift, however, would require significant efforts in terms of R&D and better understanding of consumers' expectations to inform the strengthening of the value chain.

Empowerment of women, especially female-headed households, was identified as a priority in order to increase their control on income, time and labour. It was noted that enhancing the value chain of nutrient rich foods, including fish based products, would require significant investments in processing, storage and safety but would constitute a viable income-generating activity for female producers. However, it was noted that, when designing the delivery approach, aspects including women's income control and time and labour burden should be taken into account to ensure that the intervention does not cause harm to women themselves and does not place additional constraints on their choices about child care practices.

The selected mix of interventions by decision-makers in the agriculture and fishery sector were grouped around the following areas: 1) agriculture development; 2) value chain development and 3) community or household driven development (mostly to address food security). The contribution by the health sector was seen as crucial to increase awareness and behaviour change of nutritious foods and health diets, especially among the most vulnerable population groups.

Table 21: Mix of interventions identified by decision-makers in agriculture and fishery against nutrition-relevant socio-economic factors, Yemen 2014

	On-farm / on-sea availability & diversity	Food supply in domestic markets	Income generation	Women's empowerment
Agriculture & fishery development	<ul style="list-style-type: none"> • Protect and regulate fishing activities • Increase production of competitive nutrient-rich high value crops 	<ul style="list-style-type: none"> • Increase fish supply for the domestic market • Increase measures for food safety and food standards 	<ul style="list-style-type: none"> • Introduce incentives to offset the <i>chat</i> cultivation 	
Value chain development	<ul style="list-style-type: none"> • Increase production of targeted nutritious crops • Control pesticide use 	<ul style="list-style-type: none"> • Storage & transportation • Processing • Marketing of sea food products • Marketing of targeted nutritious crops • Marketing of dairy products • Marketing of fortified foods • BCC to increase consumption of oily fish • BCC to increase consumption of healthy diversified diets 	<ul style="list-style-type: none"> • Pro-poor value chains • Support micro and small scale fish enterprises 	<ul style="list-style-type: none"> • Pro-women value chains (consideration of time/labour burden)
Community & household driven development	<ul style="list-style-type: none"> • Increase crop productivity and diversity • Support nutritional home gardening • Support small animal husbandry / poultry 	<ul style="list-style-type: none"> • Create market linkages to sell the surplus 	<ul style="list-style-type: none"> • Increase equitable access to resources by targeting poor households 	<ul style="list-style-type: none"> • Increase equitable access to resources including microcredit

Source: author

Considerations on scale and coverage of selected interventions

In terms of scale, it was agreed that, agriculture will target districts with high prevalence of stunting and high prevalence of food insecurity using a community or household driven approach. For the value chain development, the selection of districts would depend more on the urban concentration and the availability of local market infrastructures. As a result, only a sub-set of districts show overlaps between the two aspects (food security and value chains).

One of the key priorities that would represent a considerable shift from the current agriculture and fishery investments, is the emphasis on the domestic supply. This requires increased availability and affordability of nutrient-rich food items in the local markets coupled with adequate demand creation. The pathway between agriculture and nutrition would need substantial policy measures in terms of price setting and control of price volatility to ensure

that nutrient-rich food items gets into the hands of income dependent households, which represent the majority of the population in Yemen.

The community or household driven approaches tackle predominantly the better known pathway of translating production of diversified and nutrient-rich food items primarily into consumption and secondarily into income through sales of surplus. The value chain development of nutrient-rich food items has the greatest potential to simultaneously tackle consumption, income and market features provided that smallholders and women are at the core of the process. For the most impactful coverage, emphasis was placed on equitable access to resources and income. This means that services would need to be tailored to the needs of those producers with the highest vulnerability in terms of food and income security (e.g. smallholders, small families with limited labour supply, female head households, etc.). For the women, this would also mean equitable decision-making on the production means, access to finance resources and technical services and reduced labour and time burden.

Important overlaps were identified with the health and WASH sector in the areas of improving food safety and food standards, promote hygiene and sanitation practices among consumers and reduce risk of waterborne and vector borne diseases from crop irrigation and standing water.

The Ministry of Agriculture & Environment went through the highest number of iterations and changes during the consultation process. Many of the interventions that were selected from the sectoral plan were eventually excluded as it was not possible to identify any clear link between agriculture and nutrition outcomes. The final consultation provided a strong case on why the development of value chains should be tailored towards increasing the nutrition security of the most vulnerable producers. While pro-poor and pro-women considerations might improve the nutrition outcomes among those directly targeted, it was less clear how the value chains would ensure the affordability of nutrient-rich food items in the local markets.

Chapter 6: Conclusions on the applied method in the Yemen case

My research focused on child stunting, given its reflection of the cumulative effect of chronic malnutrition as opposed to child wasting, which is a manifestation of acute malnutrition and describes the nutritional status in a given time (Black et al. 2013). The prevalence of wasted children, however, was used as a secondary dependent variable of this research because of the bi-directional relationship with child stunting and because of the overlaps in the immediate and underlying determinants (Khara and Dolan 2014).

The research focused on three immediate determinants of child stunting: birth outcomes, complementary feeding practices for children 6-23 months and incidence of diarrhoea and exposure to environmental enteric dysfunction (Bhutta et al. 2013). It then expanded the scope to look for significant associations with socio-economic, demographic and environment underlying determinants.

From a policy perspective, the study aimed to answer the following question **“What mix of public interventions works best in a given context to reduce the prevalence of child stunting?”** This question brings to the forefront the relative importance of immediate and underlying determinants of child stunting and the role played by a diversity of Government sectors to address them. Findings from the study confirm that child stunting is associated with immediate and underlying determinants at individual, household and community levels (Haddad et al. 2014).

6.1 Conclusions on the findings and results

6.1.1 Consistency between global and Yemen-specific findings

This study found a noticeable consistency between the findings of the cross-country analysis and those of the Yemen specific analysis. In Chapter 2, cross-country regression analysis based on global datasets was used to identify the underlying determinants that are most significantly associated with child stunting and its immediate determinants (Fanzo et al. 2014). The main findings were further confirmed by the analysis in Yemen, explained in Chapter Four. This analysis points to the statistical significance of a set of underlying determinants including diversified diet, the importance of purchasing power to access diversified and nutrient-rich foods, maternal education, access to drinking water and improved sanitation facilities.

The study confirms that, beyond health, other sectors play a key role in the decision-making process and do have shared accountability for reducing the prevalence of child stunting. The study looked at health, agriculture, education, social protection and water, sanitation and hygiene (WASH). Through a literature review, Chapter 2 presented the *potential* of engaging relevant sectors to address the immediate determinants of child stunting. It also identified those determinants with the strongest direct or indirect association with child stunting. The Yemen case showed that the engagement of relevant sectors in the decision-making process was a journey where participants were asked to be mutually dependent on arriving together to

the negotiated destination. The final mix of interventions identified in Yemen, was based on the engagement of relevant sectors with clear responsibilities to act upon discrete determinants of child stunting. On the other hand, the absence of a representative from the social protection sector in the decision-making process resulted in the lack of interventions directed towards ensuring equal access to nutrient-rich foods, in particular by young children from income-dependent poor households.

Chapter 2 identified that almost all stunting takes place in the first 1000 days after conception (Black et al. 2013). The Yemen case confirmed that the stunting prevalence increases constantly and significantly amongst **children in the age group between 6 and 23 months** and then levels out. Of particular interest to decision-makers is the fact that the same age group is also the one most vulnerable to wasting. From a programmatic point of view, this would mean prioritizing the universal coverage of all children below two years of age in order to prevent, detect and treat malnutrition.

Chapter 2 identified **birth outcomes** as an immediate determinant of child stunting. The high prevalence of wasting among infants in Yemen was linked with poor birth outcomes, which is measured using the proxy of low birth weight (UNICEF 2013). Based on the global evidence, poor birth outcomes are strongly associated with risk factors defined by maternal age, parity and birth spacing. This is consistent with the statistics of Yemen, which consistently show a high incidence of early pregnancy, high fertility rate and high prevalence of households having more than one child with less than five years of age (CFSS 2011, UNICEF 2013 and YNDHS 2013). The lack of a big enough sample on birth outcomes hampered a comprehensive analysis on the magnitude, determinants and consequences of this phenomenon in Yemen.

Chapter 2 identified **child diarrhoea** as the most important infectious disease determinant of stunting of linear growth. Results from a pooled cross countries analysis showed that the odds of stunting at 24 months of age increased multiplicatively with each diarrhoea episode or day of diarrhoea before that age (Black et al. 2013). The Yemen regression analysis based on the 2011 CFSS dataset only showed a significant association between child diarrhoea and child wasting while the 2013 UNICEF baseline reported also an association with child stunting, although much weaker. All three population-based surveys (CFSS 2011, UNICEF 2013 and YNHDS 2013) confirmed that the group with the highest incidence of diarrhoea is the one between 6 and 23 months of age. Of most interest to decision-makers was the strong statistical associations between child stunting or child wasting with poor access to safe drinking water and unimproved sanitary conditions. These findings are consistent with the global evidence on the **environmental enteric dysfunction**, which is a common condition amongst children continuously exposed to contaminants in the water, food and environment (Humphrey 2009, Campbell et al. 2003, Lunn et al. 1991).

Chapter 2 identified **appropriate complementary feeding practices for children between 6 and 23 months** of age as an immediate determinant for reduced stunting prevalence (Bhutta et al. 2013). This was confirmed by the regression analysis in Yemen, which found a strong and

statistically significant association between the probability of being stunted or wasted and the number of food groups and animal-protein foods that were consumed by a child in the age group between 6 and 23 months. The Yemen regression analysis also confirmed the expected association of child diet diversity with maternal education levels and with the household socio-economic status and main source of income as illustrated in Chapter 2 (Fanzo et al. 2014).

As expected, **adequate breastfeeding practices** did not show any association with child stunting or child wasting (Black et al. 2013). Differently from the global evidence, however, the regression analysis in Yemen did not find any association between breastfeeding practices and child diarrhoea (Black et al. 2013). This might be due to the quality of the data in Yemen, particularly the sample size and the low prevalence of adequate breastfeeding practices. Of interest to the decision-makers in Yemen, was the fact that affluent and educated mothers who were most likely to attend antenatal care services or give birth in a health facility or with a skilled birth attendant, did not show a better uptake of breastfeeding practices. On the contrary, the descriptive findings showed that the highest prevalence of early breastfeeding and exclusive breastfeeding was amongst mothers without education and from the poorest wealth quintiles. These findings appear to suggest that adequate practices in Yemen are influenced by the lack of alternatives to breastfeeding rather than by informed individual choices. Results from the focus group discussions conducted by UNICEF in 2013 also confirmed that mothers pointed to their limited purchasing power as the main reason for practicing exclusive breastfeeding during the first six months of their new-born's life. These findings call for working closely with private companies in the context of regulated marketing of Breast-Milk Substitutes, including addressing unlawful practices by health practitioners at the time of antenatal care and delivery services.

6.1.2 Consistency between chosen nutrition-specific interventions and global evidence

The nutrition-specific interventions identified in the *2013 Lancet Series on Maternal and Child Nutrition* as having a direct impact on child stunting include: promotion of appropriate complementary feeding practices for children between 6 and 23 months and preventive zinc supplementation. The interventions with an indirect impact on child stunting include all the ones for optimum maternal nutrition, breastfeeding promotion, Vitamin A supplementation and management of acute malnutrition.

Decision-makers in Yemen acknowledged the Lancet recommendations as their guidance for the selection of the mix of interventions. However, final decisions were based on operational considerations, which resulted in significant variations in terms of implementation. For example, the health sector opted to scale up the **Iron and Folic Acid (IFA) supplementation** as part of the antenatal care service instead of the internationally recommended maternal multiple micronutrient (MMN) supplementation (Bhutta et al. 2013). The main reason given by the decision-makers was the considerably higher cost of the MMN supplements and the fact that the IFA supplementation in Yemen had an unknown baseline coverage in terms of access and compliance. Based on a similar reasoning, the health sector decided to scale up the **Zinc**

supplementation for the treatment of diarrhoea instead of the internationally recommended preventive Zinc supplementation. The main justification for this decision was that Zinc supplementation for diarrhoea management was already part of the minimum child health care package in Yemen although with a low baseline coverage. Implementing the preventive Zinc supplementation would have first required the identification and testing of a delivery platform. Most importantly, at the time of the workshop in 2014 and until now, there are no other countries that have experience with implementing preventive Zinc supplementation on a large scale.

The scaling up of **Vitamin A supplementation** and the **Severe Acute Malnutrition Management** were included as part of the minimum child health care package as per international recommendation. It should be noted, however, that the regression analysis in Yemen could not find any significant association between Vitamin A supplementation and child wasting or child stunting. This might be due to the sample size and also to the low reported coverage of Vitamin A supplementation (CFSS 2011). No data were available from population-based surveys on the access to acute malnutrition treatment. Given the high prevalence of child acute malnutrition and the great share of health investments going into its detection and treatment, questions on the access to acute malnutrition treatment should be included in population-based surveys.

For the **promotion of early and exclusive breastfeeding for 6 months**, the representatives from the health sector in Yemen decided to include the Baby Friendly Hospital Initiative (BFHI) based on the premise that the training of health professionals should be accompanied with measures to enact the implementation of the International Code of Marketing of Breast-Milk Substitutes (BMS). Community-based promotion of breastfeeding using trained female peer-counselors was included as a complementary option to reach pregnant and lactating women in their houses. This decision was in line with the evidence presented in Chapter 2 whereby the use of peer-counsellors conducting home visits is considered most effective in countries like Yemen, which are characterized by low female literacy and low female employment (Fanzo et al. 2014).

The **promotion of a diversified nutrient-rich diet** for children between 6 and 23 months, adolescent girls and pregnant or lactating women was an issue extensively discussed among the representatives from the engaged sectors. All of them agreed that this should be a joined activity whereby consistent messages are developed and delivered through the existing range of delivery platforms such as the community-based health or WASH peer-counselors, the school-based health clubs and the consumers' awareness multi-media campaigns.

Of the internationally recommended nutrition-specific interventions, the most debated one was the **provision of balanced energy-protein food supplements for pregnant or lactating women** and the **provision of complementary food supplements for children between 6 and 23 months** in food insecure populations (Bhutta et al. 2013). Decision-makers from the health sectors prioritized efforts to detect and treat acutely malnourished women and young children with food supplements. For decision-makers from the agriculture sector, the provision of nutrient-rich foods implied the capacity to provide the most vulnerable rural households,

especially the female-headed ones and those with young children, with adequate inputs, including small animals. Two additional delivery mechanisms that were mentioned but not discussed included the emergency food distribution and the partnership with private retailers.

6.1.3 Consistency between chosen nutrition-sensitive interventions and global evidence

6.1.3.1 Interventions in the WASH sector

The regression analysis in Yemen showed what is confirmed in several studies referenced in Chapter 2 (Dangour et al 2013; Spears 2013; Hammer and Spears 2013; Quattri and Rand 2014; Quattri et al. 2014a, 2014b). **Access to drinking water supplies and improved sanitation facilities** is associated with reduced child stunting prevalence. Decision-makers prioritized coverage of improved sanitation facilities and a cleaner inter-village environment as essential requisites to see diminished child diarrheal incidence and child stunting prevalence. For that matter, decision-makers in Yemen emphasized that the biggest share of investments for improved sanitation facilities needed to come from the households themselves. Hence, behaviour change communication strategies were identified as the most effective pathway to be concurrently pursued by the education, health and agriculture sectors using their relevant delivery platforms. The community-led total sanitation approach was identified as the most effective way to promote latrines for the safe disposal of human faeces as well as to create a clean environment that is less exposed to soil and animal contaminants.

While the global evidence (Fanzo et al. 2014; Cairncross 2003; Shahid et al. 1996) points to the central role of hand washing with soap to reduce child diarrheal incidence and prevent child stunting and child wasting, the analysis in Yemen could not find any significant association. This might be due to the quality of the data, which may overlook the gap between the knowledge and the actual practice of hand washing. This gap was confirmed through the focus-group discussions conducted by UNICEF (2013). Decision-makers from the health sector pointed out the need to prioritize the hygiene messages around feeding practices of young children, especially stressing the importance of hand washing with soap prior to meal and food handling and also emphasizing complementary food hygiene as an important measure.

A statistically significant association was found between child stunting and the storage of drinking water in clean containers, which is an indicator of water quality at point of use and one of the key hygiene practices promoted at household level. The link between the community-led total sanitation approach and the community-based nutrition education was seen as a potential way to improve both hygiene and feeding practices in order to reduce the incidence of diarrhoea and the exposure to environmental enteric dysfunction among the youngest children.

6.1.3.2 Interventions in the education sector

School feeding programmes are often included as a social protection measure, especially in highly deprived areas (Ruel 2013). In Yemen, the provision of meals and take home food rations was included in the mix of interventions with the aim of closing the gap in terms of enrolment

and attendance of girls aged 10-11 years and beyond. One important policy measure adopted in Yemen was to extend the support to secondary school in order to create an incentive for girls to progress in schooling. Keeping girls in school was seen by all decision-makers as the most effective way to prevent early marriage and pregnancy. The interventions included by the education sector were primarily supply-oriented projects to create safe learning environments for girls. Interventions included the construction of separate classrooms and toilets and the expansion of school feeding programmes in all food insecure districts. Demand-oriented conditional cash transfers were discussed as a potential cost-effective way to increase girls' attendance and to provide an incentive against early withdrawal for domestic labour or for early marriage. Conditional cash transfers were not included in the mix of interventions.

6.1.3.3 Interventions in the agriculture and fishery sector

The regression analysis in Yemen showed that the **access to own production is associated with the diversity of diet consumed by children between 6 and 23 months** of age. Children from agriculture and fishery households significantly outperformed children from all other livelihood groups in terms of access to number of food groups and access to animal-protein sources. When narrowing down the regression analysis to only agriculture households, factors such as the size of the land, availability of irrigation water or number of different types of livestock per household did not show any significant association with the number of food groups or the number of animal-protein sources consumed by the child. This might be because young children only need small quantities of a high variety of foods to ensure the minimum diet diversity required for a healthy growth (WHO 2008).

The results from the regression analysis had two significant policy and programmatic implications. First, the findings did not fully justify the expansion of home-gardening among the producers as the measure proposed by the agriculture sector to improve child diet diversity in Yemen. Second, the findings suggested that, beyond the dietary intake, other factors could be a better predictor of child stunting amongst agriculture and fishery households, including exposure to unsafe drinking water and unclean environment. These findings are consistent with global studies that have shown the significant relationship between access to animal-based products and improved child diet in low-resource settings (Murphy et al. 2003, Leroy et al. 2007). On the other hand, animal waste, if not properly managed, introduces toxic faecal coliforms, which increase the risk of environmental enteric dysfunction among young children (Humphrey 2009).

The discussion about the **provision of nutrient-rich foods** for pregnant and lactating women and for young children between 6 and 23 months, brought up two types of considerations: first, how **affordable** the nutrient-rich foods were or could be in the domestic market and, second, how **accessible** the nutrient-rich foods were or could be for income dependent poor households.

While the availability of diversified foods in the domestic markets was not considered a major issue in 2014, concerns were raised by decision-makers on the sustainability of the food systems in Yemen due to the widespread cultivation of *chat* and the competition over scarce and diminishing water. The improvement of the **value chains of nutrient-rich fresh foods**, especially by introducing postharvest and storage technologies, was identified by representatives from the agriculture and fishery sectors as one of the most effective pathways for improving people's diets as well as for generating income and employment in rural and coastal areas. Additional measures included supporting the trade of nutrient-rich foods in the domestic markets and promoting widespread nutrition education among consumers. These decisions were consistent with the evidence from the literature review in Chapter 2, which included, among others, diversifying supply and investing in R&D (Remans et al. 2014) and promoting nutrition education at population level (Herforth et al. 2012).

The descriptive analysis in Yemen pointed out that income dependent households from the poorest quintiles could not afford nutrient-rich foods such as animal-based products, fruits and vegetables. This meant that, for young children from these households, the only way to access nutrient-rich foods was if these were part of **direct food transfers** or linked to **cash transfers**. As described in Chapter 2, there is significant evidence on the role of cash transfers in improving household food diversity, especially when these are directed to women as they tend to spend a larger proportion to increase the consumption of animal-based products, fruits and vegetables (Schady and Rosero 2008; Fiszbein et al. 2009; Angelucci and Attanasio 2009; Fiszbein et al. 2009; Leroy et al. 2009). Social protection programmes that have provided fortified foods and supplements for mothers and young children have also shown promising results in the intake of micronutrients (Bassett 2008; Leroy et al. 2008). Despite the potential effects, food and cash transfers were not included in the mix of interventions by the decision-makers in Yemen due to the absence of representatives from the social protection sector. At the time of the consultation, the cash transfers in Yemen were adjusted to the volatility of the fuel price but not to the volatility of the food price. Additional limitations of the Yemen Welfare Social Fund that were mentioned by the decision-makers included the lack of clear criteria in terms of who was benefitting and the absence of linkages with health and/or education services. Hence, despite the significant investments that were going into social protection, the potential to make the programme more nutrition-sensitive remained untapped at the time of the consultations in 2014.

6.1.3.4 Gender-sensitive approaches

The global evidence shows that women are key mediators in the pathways between inputs, intra-household resource allocation and child nutrition (van den Bold et al. 2013; Ruel 2013). Decision-makers acknowledged that the role of women in Yemen is compromised by their gender inequality¹². Decisions about pro-women approaches had to take into account the

¹² With a Gender Inequality Index of 0.733, Yemen ranked at the bottom of the 149 countries measured in the 2014 UNDP Human Development Report.

implications in terms of social status, control over resources and domestic workload. Each of the identified interventions was assessed in view of what could be the potential effect on the safety, health and nutritional status of the targeted women and their children.

Since the adoption of the International Social Protection Floors Recommendation in 2012 a number of Governments in low and middle-income countries have included **maternity leave** as a way to extend social security coverage to those most in need. There are examples of Government-funded employment schemes that have included measures to protect women at risk of heavy and hazardous work during their pregnancy and breastfeeding time. Given the low female employment rate in Yemen, decision-makers in the agriculture, livestock and fishery sector only marginally discussed regulations on maternity leave.

As expected, the descriptive analysis in Yemen showed that educated mothers were less likely to have stunted children and more likely to access basic health services for themselves and their children. Keeping **girls in school** was seen by decision-makers as the most effective pathway to delay the age of marriage and first pregnancy given the close link between the two in Yemen. However, no intervention was identified for girls that were already out of school.

Optimizing birth spacing was found to be the biggest unmet demand in Yemen for married women younger than 30 years, while **limiting births** was found to be the biggest unmet need among women aged 30 or older. The unmet need for family planning was higher among rural women (33 per cent) and amongst those with no education (33 per cent). The regression analysis in Yemen showed a strong and statistically significant association between the number of children below five years of age and the probability of a child between 6 and 23 months being stunted. In the context of Yemen, optimal birth spacing was also seen as being beneficial to reduce the risk of girls being withdrawn from school to take care of their younger siblings, which was the main reason provided for early drop out among poor households. Decision-makers in the health sector did not include the expansion of family planning in the mix of interventions as they considered that this was already adequately covered by existing investments.

6.2 Conclusions on the research method

This study makes a strong case for an approach that goes beyond health and requires coordinated efforts by key sectors to address both the immediate and underlying determinants of child stunting. In line with the 2013 Lancet series, the identified nutrition-sensitive interventions address the underlying determinants of child stunting but can also serve as delivery platforms for the uptake of specific nutrition practices such as appropriate complementary feeding for children between 6 and 23 months. While interventions themselves might be single sector in nature, the study confirms the importance of ensuring that these efforts converge around the needs of the children at highest risk of becoming stunted because of their age, their residence or more specific family circumstances (Garret et al. 2011).

Most importantly, this study shows that while a comprehensive analysis can inform the multi-sectoral planning process, decisions by each sector will be mostly influenced by their implementation reality. Leaving the last decision to each sector can avoid multi-sectoral planning being perceived as a top-down technocratic approach with no clout for translating ideas into results. Past failures described in Section 2.8 have been explained by a mismatch between the level of ambition and the lack of political support, resources and capacity (Mokoro 2015; Field 1987; Berg 1987). Prior to the current crisis, Yemen had an unprecedented high-level political support for nutrition, which was instrumental in bringing most of the key Government sectors and development partners to the discussion table. The quantitative analysis was meant to inform decision-makers on what mix of interventions could have the highest results in reducing child stunting, taking into account global recommendations and, especially, the implementation reality in Yemen.

The Yemen case confirms two key points. First that each sector, beyond health, feels accountable for how their selected interventions will address distinctive determinants of child stunting as identified from the quantitative analysis. Second that the impact on child stunting is seen as ultimately dependant on what all key sectors are going to do collectively. The capacity to converge efforts requires a combination of different modalities of working together. The Yemen case showed that these modalities can range from exchanging information to ensuring that interventions are converged in terms of timing and targeting by population or by geographic area. In addition, all participants in the decision making process highlighted the need to jointly work on selected specific products such as the communication strategy or a series of trainings for frontline practitioners. The discussion among decision-makers of Yemen did reflect the fundamental requisite for nutrition, which is to ensure that available resources and actions bear at the same time and place on the same child. While young children remained the primary focus of the discussion on nutrition impact, the phenomenon of early pregnancy in Yemen was highlighted as a matter of urgency. This was to ensure that the girls themselves achieve their personal physical and mental growth before becoming mothers.

The Yemen case also shows that, whilst decision-makers and experts knew what should be done and also how things could be done differently, the political dynamics, in certain instances, limited the collective ability to co-determine nutrition results. The most obvious demonstration was the absence of representatives from social welfare, which controlled the biggest share of the public investments and, possibly, had the highest degree of public scrutiny.

The agreement on a mix of interventions and related results, which could be directly or indirectly associated to child stunting, was seen as the fundamental first step towards increased transparency, inclusion and ownership by the relevant sectors. The quantitative analysis was considered useful by decision-makers as long as it provided them with tangible clues in their negotiation process. Interviews with key national and international decision-makers confirmed that, from a public investment perspective, the most valuable findings from the analysis were those that could be acted upon with concrete policy or programmatic decisions. Participants

selected those findings that, based on their knowledge and experience, could work the most in the given political, institutional, cultural and financial context.

The method, which used both descriptive and statistical analysis, brought to the national discussion a better understanding of the immediate and underlying determinants of child stunting. How the findings from the analysis were used for final decisions was ultimately influenced by who had a “seat at the table”. The collective ability to co-determine nutrition results was heavily influenced by the political and institutional context. For example, the key issue of ensuring access to nutrient-rich foods for income-dependent poor households was not properly discussed due to the absence of representatives from the social protection sector. As a result, increasing consumption through home-gardening among vulnerable rural households was the only food security measure included in the mix of interventions.

The final decisions show that trade-offs were constantly applied by decision-makers in order to choose which interventions to include and which ones to exclude. The plenary discussions among sectoral representatives were instrumental when decisions needed to be taken on how to deal with overlaps in terms of geographic areas and population groups. Final decisions on what interventions were included by the Ministries tended to be heavily influenced by current domestic investments. Innovative approaches were sought only if there was a clearly identified commitment by external donors. The only exception was the Ministry of Fisheries, which was new in the nutrition debate and saw the entire process as an opportunity to engage with non-traditional investors.

Decision-makers found the method beneficial to the extent it provided them with facts and figures to justify their policy and programmatic choices. Contextual findings for nutrition such as individual and household characteristics were regarded as useful in order to influence the criteria for the population targeting. It was made clear during the workshop and from individual feedback that it was close to impossible to change institutional arrangements without the influence of development partners and potential access to new funding. In essence, changes were judged as “costing money” and the Ministries were not ready to collect the bill to make those adjustments.

6.2.1 Strengths and weaknesses of the research method

The applied research method helped decision-makers to systematically go through a set of findings, which showed a statistically strong association with child stunting and were also relevant from a policy and programmatic perspective. Taking the demographic group of children between 6 and 23 months of age, the analysis found that a number of determinants increased the probability for a child to be stunted. These determinants included, among others, the presence of other siblings below five years of age, the economic and nutritious status of the mother (e.g. female head of household and malnourished mother), the child’s access to a diversified and animal-protein rich diet (expressed in number of food groups) and an unsanitary setting (e.g. open defecation). Going through the findings helped decision-makers in each

relevant sector to consider 'how' they could contribute towards reducing child stunting by addressing the discrete determinants that were part of their own policy and programmatic responsibilities.

This study confirms that findings from the quantitative analysis can help decision-makers to inform prioritization of programs that address discrete determinants of child stunting. The consultation process with decision-makers or influential advisors showed that focusing the discussion around key findings helps them to decide which interventions should be included or excluded. In practical terms, informed discussions, especially plenary consultations, acted as a deterrent for decision-makers to promote one type of program rather than another purely on the basis of their own interests.

The extent to which the findings influenced plausible trade-offs within current programs, to get better nutrition outcomes for existing investments, depended very much on each sector and its institutional arrangements. The findings from the quantitative analysis, for example, emphasized the importance to specifically target certain groups such as young children below two years of age, adolescent girls, pregnant and lactating women and poor households, particularly those that are income dependent. However, applying this type of targeted approach was seen as carrying political, institutional and financial risks. Sector decision-makers were not willing to take risks unless there were clear incentives, like high-level political buy-in or external donor investments.

Final decisions on the appropriate mix of interventions were influenced by the existing relationships between actors. Policy and programmatic choices were determined by institutional arrangements and financing opportunities. In essence, the Yemen case showed that the political and institutional constellation can heavily shape a collective ability to co-determine nutrition results. While converged geographic targeting appeared to generate rapid consensus amongst decision-makers, shifts in demographic targeting to effectively cover specific population groups with current programmes were seen as requiring much more intra-sectoral consultations and adjustments.

The developed research method was tailored to be of use for decision-makers. The breadth of findings was expected to 'speak' to a wide range of participating sectors. This was regarded as an essential feature to inform a debate where decisions needed to be taken by juggling political, institutional, cultural and financial considerations. While there was a recognizable trade-off between the breadth and depth of the research scope, this study confirms that results that inform multi-sectoral planning and decision-making are most useful when they show how different elements come together into a coherent picture. This study was tailored to the decision making process at national level. The analysis did capture the geographical dimension in order to ensure that the collaborative efforts were targeted and combined in the same vulnerable districts. The same method could be further replicated at sub-national level to ensure the collaborative efforts are targeted at the most disadvantaged households and communities. In countries where programmatic and investment decisions are highly

decentralized, the first step of the descriptive and quantitative analysis could start at sub-national level to increase the granularity of the findings.

The quantitative analysis was deemed sufficient by decision-makers to provide a snapshot, in a given time, on the most significant associations between child stunting and the immediate and underlying determinants. However, it did not capture the time dimension due to significant limitations of the available datasets. Despite significant investments on population-based surveys in Yemen, it was impossible to get comparable datasets from two or more survey-rounds with the same sample design. This would have enabled the analysis of trends in order to get a better understanding on which variables could be associated with changes over time. Without a coordinated approach in the generation of data, there will always be limitations in what can be done with the analysis of the data and the usability of the results.

6.3 Summary and next steps

In Chapter 2 I presented a literature review on the available evidence base to support proven interventions and approaches towards reducing child stunting. The results from the analysis presented in Chapter 6 confirmed that some of the global evidence does apply to the Yemen context. The results from the analysis in Yemen were therefore useful to bring a number of international recommendations into the national debate.

Firstly, the national findings confirmed global evidence that the most critical time is the so called '**first 1000 days**' that covers the growth and development needs of children from conception till their second birthday. In the Yemen specific context, however, it was agreed that **adolescent girls** should receive equal attention because of the widespread phenomena of early marriage and early pregnancy. A close assessment of the current interventions in Yemen brought to the attention of decision-makers that adolescent girls are largely invisible in all sectors with the exception of education.

Second, the significant association between child stunting and **maternal characteristics** reinforced the commitment to increase the effective coverage of basic services targeted at women by closing the access gap. For health interventions this implied prioritizing the coverage of pregnant and lactating women in rural areas, especially those that are most likely to have malnourished children due to their own nutritional status or their socio-economic circumstances. The agriculture sector committed to specifically target female-headed households to increase their food security through better access to income and/or diversified homestead production. However, it was noted that economic activities should not come at the expense of the women's capacity to take care of themselves and their children, which is a risk that could ultimately offset the potential nutrition gains.

Third, the study showed that **rural populations** are far from being a homogenous group of people with the same nutritional requirements. The levels of nutritional vulnerability in Yemen were significantly affected by the main source of livelihoods with the income-dependent

households being at higher risk when compared with households engaged in agriculture, livestock or fishery. Indeed, the **households dependent on agriculture wage or on welfare support are those that are the most food insecure as well as the poorest**. How to deal with income-dependent poor households showed the largest misalignment between the findings from the quantitative analysis and the mix of interventions that were agreed upon by the decision-makers in Yemen. One limiting factor could have been that the discussion was led by the agriculture and fishery sector with a strong focus on the production and delivery systems and some attention given to the behaviour changing aspect of the consumers. The discussion overlooked how the nutrient-rich foods could effectively get into the majority of peoples' hands, especially those that were dependent on a wage. Issues concerning food prices and purchasing power were mentioned but were not addressed with any tangible measure. This omission occurred despite the acknowledgment that 90 % of households reported high food prices as their main shock and despite the fact that wage labourers (agriculture and non-agriculture) had the highest percentage of food related debts.

Fourth, **low birth weight prevention and management** was another area with some misalignments between the findings from the quantitative analysis and the mix of interventions that were agreed upon by the decision-makers in Yemen. Data showed that a very high prevalence of infants below six months of age were exposed to inappropriate breastfeeding practices, high prevalence of diarrhoea and acute malnutrition. Given the statistics, it was reasonable to assume that maternal age, parity and birth spacing were all significant risk factors of low birth weight in Yemen. However, due to the sampling limitations, a separate regression analysis could not be performed between low-birth weight and a set of potential immediate and underlying determinants. Hence, no interventions were identified to specifically address low-birth weight prevention. In terms of low birth weight management, global evidence points to the centrality of practicing exclusive breastfeeding for the first six months of an infant life, even in settings with significant prevalence of low birth weight (WHO 2013). Increasing the effective coverage of basic health services such as antenatal care, safe delivery and child growth monitoring was prioritized by the decision-makers as the precondition before noticeable changes could be seen in the uptake of breastfeeding. However, this assumption did not take into account that educated mothers, who were the main users of health services at critical times, were also those less likely to practice early and exclusive breastfeeding. The Baby Friendly Hospital Initiative (BFHI) was identified as the certification process to promote the quality of the service and to monitor the implementation of the International Code of Marketing of Breast-Milk Substitutes (BMS). The discussion, however, failed to critically assess the behavioural and social factors that are limiting the uptake of exclusive breastfeeding in Yemen and the role of the private sector in influencing such behaviours.

The findings from the descriptive and quantitative analysis helped the decision-makers to select the mix of public interventions with the highest potential for reducing child stunting in Yemen. An important notion that this process highlighted was the value of converging the sectoral efforts into the most vulnerable geographic areas and population groups.

The method highlighted a number of limitations in the nutrition debate that most likely are not exclusive to the Yemen context and could provide the starting point for further research.

Firstly, it is important to assess how decision-makers in health, agriculture, social protection and WASH are able to bring **adolescent girls** to the forefront of their policy and programmatic choices. This is part of a broader discussion on how the **gender lens** can be better incorporated into the nutrition debate, especially in contexts where female status remains a sensitive topic from a cultural and social perspective. This is even more urgent in situations where girls are not allowed to grow into their full mental and physical potential before they themselves become mothers.

Affordability and accessibility of diversified nutrient-rich foods for non-producers, both in urban and rural areas, is an overlooked issue in the nutrition debate, not only in Yemen. The widespread growing phenomenon of income-dependent poor households in rural areas requires solutions that go beyond the current focus on production. Homestead production is often proposed as the default measure to increase food and nutrition security. However, new approaches should take into account that a large share of rural people do not own land and livestock anymore but live from wage labour, similar to their urban counterparts. This calls for approaches to address more systemic issues of inequality in the supply system, including the need to adjust wages to food prices.

Finally, while this research had a focus on public interventions and financing, findings from the analysis show how much the **private sector** has a stake in the nutrition debate. The overall debate would have been enriched by engaging businesses in order to incorporate their perspectives into the consultation with decision-makers. The method could be further refined to better examine the **range of stakeholders** that have a key role in each sector and how much they influence public decisions in health, agriculture, education, social protection and WASH. This would add a further layer of complexity to the analysis but would be timely and much needed in the nutrition debate, especially if the aim is to better assess the potential impact of multi-stakeholder approaches to child stunting reduction.

Although the importance of employing multi-sectoral approaches for improving nutrition outcomes is widely recognized by the international nutrition community, in reality there is still little guidance on how to do it. The method presented here is meant to help decision-makers get the most out of available data by encouraging them to systematically explore how their sectoral efforts will address key determinants of child stunting and collectively contribute to a reduction of the prevalence of child stunting. The method recognizes the individual responsibility of each sector to implement what they have planned to do. It also highlights that collective impact will depend largely on the willingness and capacity of the engaged sectors to converge their efforts into the same vulnerable households and communities. Essentially, this method demonstrates that child stunting, as a sign of chronic malnutrition, is not just a health problem but rather a social development issue that requires multi-sectoral approaches.

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Annex 1: Glossary of Key Terms

Acute malnutrition (wasting): low weight-for-height defined as more than 2 standard deviations (SD) below the mean of the sex-specific reference data. Wasting is usually the result of a recent shock such as lack of calories and nutrients and/or illness, and is strongly linked to mortality.

Anaemia: The condition of having a hemoglobin concentration below a specified cut-off point, which can change according to age, gender, physiological status, smoking habits, and altitude at which the population being assessed lives. The World Health Organization (WHO) defines anemia in children under five years of age and pregnant women as a hemoglobin concentration <110g/l at sea level. Although the primary cause of anemia worldwide is iron deficiency, it often coexists with a number of other anemia causes, including malaria and other parasitic infections; acute and chronic infections that result in inflammation and hemorrhages; deficiencies in other vitamins and minerals, especially folate, vitamin B12 and vitamin A; and genetically inherited traits, such as thalassemia.

Bio-fortification: The development of micronutrient-dense staple crop varieties using traditional breeding practices or biotechnology.

Body Mass Index (BMI): A measure of body fatness, calculated as weight (kg) divided by the square of height (m²). A BMI of <18.5 is considered underweight, ≥25 signifies overweight, and ≥30 signifies obesity. Although BMI is a good measure for determining a range of acceptable weights, it does not take into consideration some important factors, such as body build, i.e., relative contributions of fat, muscle, and bone to weight.

Breastmilk substitute: Any food marketed or otherwise represented as a partial or total replacement for breastmilk, whether or not suitable for that purpose.

Chronic malnutrition (stunting): low height-for-age, defined as more than 2 SD below the mean of the sex-specific reference data. Stunting is the cumulative effect of long-term deficits in food intake, poor caring practices, and illness.

Complementary feeding practices: A set of 10 practices recommended for caregivers to implement from 6 to 23 months, at which point breastmilk and/or breastmilk substitutes alone are no longer sufficient to meet the nutritional needs of growing infants. Poor breastfeeding and complementary feeding practices, coupled with high rates of infectious disease, are the principal causes of malnutrition during the first two years of life.

Complementary food: Any food, whether manufactured or locally prepared, suitable as a complement to breastmilk or to infant formula, when either becomes insufficient to satisfy the nutritional requirements of the infant (at about 6 months of age).

Conditional Cash Transfer (CCT): A social safety net program aimed at reducing both present and future poverty by linking a targeted transfer of cash to compliance with a pre-specified investment, usually in child education or health.

Decision-makers: Those making final policy decisions (e.g. heads of ministries in health or agriculture but also finance or planning). In this research, decision-makers include also influencers: those not making final policy decisions but able to influence them – from donors to mid-level bureaucrats or civil society actors (including representatives from religious, labour and community-based organizations).

Demographic targeting: A targeting method in which eligibility is based on age.

Diarrhoea: The passage of three or more loose or liquid stools per day or more frequently than is normal for the individual. Diarrhoea is usually a symptom of gastrointestinal infection, which can be caused by a variety of viral and parasitic organisms. Severe diarrhoea leads to fluid loss and plays a particularly important role in nutrition and growth faltering, because of its association with malabsorption of nutrients and appetite suppression.

Donor: A donor in this context refers to any external agency that makes a contribution (usually financial) towards a certain programme or intervention.

Early initiation of breastfeeding: Initiation of breastfeeding within one hour of birth. As a public health statistic, it is measured as the proportion of children born in the past 24 months who were put to the breast within one hour of birth.

Exclusive Breastfeeding (EBF): The feeding of an infant only with breastmilk from his/her mother or a wet nurse, or expressed breastmilk, and no other liquids or solids except vitamins, mineral supplements, or medicines in drop or syrup form.

Food-based transfer/food-based safety net program: Intended to support food consumption. It is tied to food either directly or through cash-like instruments (food stamps, coupons) that may be used to purchase food.

Food fortification: The addition of one or more micronutrients (vitamins and minerals) to a food during processing. Ideally, food fortification provides a public health benefit with minimal risks to health in the population.

Food security: According to the UN FAO, food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritional food to meet their dietary needs and food preferences for an active and healthy life. The concept of food security includes the pillars of food availability, access, utilization, and stability/vulnerability.

Global acute malnutrition: Weight-for-height of -2 z-scores or more below the median, according to the WHO's child growth standards (moderate and severe wasting).

Governance: Process for systematic accountability and oversight within and across organizations to ensure ethical practices

HIV/AIDS: Human immunodeficiency virus (HIV) is a retrovirus that affects cells of the immune system, destroying or impairing their function. As the disease progresses, the immune system becomes weaker, and the person becomes more susceptible to infection. The most advanced stage of HIV infection is acquired immunodeficiency syndrome (AIDS).

Home garden / homestead food production: A small plot or plots around the home, managed by household members, where a variety of crops including vegetables, fruits, legumes, tubers, non-food plants, e.g., medicinal herbs, spices, fuel material are grown throughout the year and often livestock and fish are raised, primarily for household consumption. They typically use low-cost inputs and indigenous varieties, as well as local knowledge and practices and community participation. Home gardens have multiple uses, including improving diets within the household, provide inputs for other farm activities, e.g., fodder for animals, provide shade or natural fencing, raise income from the sale of garden produce, and empower women, who most typically manage home gardens.

Infant and Young Child Feeding (IYCF): Refers to specific recommendations and guiding principles for optimal nutrition, health, and development of children. A set of eight population-level IYCF indicators have been developed to: (i) assess IYCF trends over time; (ii) improve targeting of interventions; and (iii) monitor progress in achieving goals and evaluate the impact of interventions (WHO, 2008).

International Code on Marketing of Breastmilk Substitutes (BMS): A set of recommendations to regulate the marketing of breastmilk substitutes, feeding bottles, and teats. This code aims to contribute “to the provision of safe and adequate nutrition for infants, by the protection and promotion of breastfeeding, and by ensuring the proper use of breastmilk substitutes, when these are necessary, on the basis of adequate information and through appropriate marketing and distribution” (Article 1).

Low Birth Weight (LBW): A birth weight of less than 2,500g. At the population level, the proportion of infants with a low birth weight often serves as an indicator of a multifaceted public health problem that includes long-term maternal malnutrition, ill health, hard work, and poor health care in pregnancy.

Malnutrition: Poor nutritional status caused by nutritional deficiency or excess (undernutrition or overweight and obesity).

Mid-Upper Arm Circumference (MUAC): The circumference of the upper arm measured at the mid-point between the tip of the acromial process (shoulder) and the tip of the olecranon process (elbow).

Micronutrient(s): Vitamins and minerals that are needed in small amounts by the body to produce enzymes, hormones, and other substances essential for proper growth and

development. Iodine, vitamin A, iron, and zinc are the most important in terms of prevalence and severity; deficiencies are a major threat to the health and development of populations worldwide, particularly children and pregnant women in low-income countries.

Micronutrient deficiency/deficiencies: Deficiencies in one or more essential vitamin or mineral, often caused by disease and/or lack of access and/or consumption of micronutrient-rich foods such as fruit, vegetables, animal products, and fortified foods. Micronutrient deficiencies increase the severity and risk of dying from infectious disease such as diarrhoea, measles, malaria, and pneumonia. More than two billion people in the world are estimated to be deficient in iodine, vitamin A, iron, or zinc.

Microfinance: The provision of small-scale financial services to people who lack access to traditional banking services; usually implying very small loans to low-income clients for self-employment or entrepreneurial activity, often with the simultaneous collection of small amounts of savings.

Moderate Acute Malnutrition (MAM): Weight-for-height between -2 and -3 standard deviations below the mean of sex-specific reference data (moderate wasting).

Multiple Micronutrient (MMN) powder: A tasteless powder that comes in the form of individual sachets, containing the recommended daily intake of 16 vitamins and minerals for one person. They can be sprinkled into home-prepared food after cooking or just before eating.

Multi-sector: Involvement of sectors beyond health. This research has focused on the following non-health sectors: agriculture, education, social protection and water, sanitation and hygiene. While agriculture, health and education have often a clearly identifiable Minister, social protection and WASH may sit in different ministries, departments and agencies.

Multi-sectoral approach: This research does not treat nutrition as a “sector” but rather as a complex development issue that requires inter-organizational and inter-agency efforts that promote participation of people of concern, interdisciplinary cooperation and coordination across key sectors, including (but not limited to) health, agriculture, education, social protection and WASH.

Multi-stakeholder: Involvement of more than one of the three structures of society, including public sector, private sector and civil society.

Nutrition security: The ongoing access to the basic elements of good nutrition, i.e., a balanced diet, safe environment, clean water, and adequate health care (preventive and curative) for all people, and the knowledge needed to care for and ensure a healthy and active life for all household members.

Obesity: A condition characterized by excess body fat, defined as a BMI of 30 or more.

Oral Rehydration Solution/Salts (ORS): A liquid electrolyte solution that is used for the management of diarrhoea among children. ORS is typically distributed in ready-to-use sachets that are added to one liter of clean water.

Oral Rehydration Therapy (ORT): A type of fluid replacement used to prevent or treat dehydration, especially from diarrhoea. It involves drinking water with modest amounts of added salt and sugar (an oral rehydration solution) while continuing to eat. The World Health Organization provides indications, preparations and procedures for ORT.

Overweight: A condition characterized by excess body fat, defined as a BMI between 25 and 30 kg/m².

Private sector: An umbrella term incorporating the business / corporate / for-profit organizations and agencies.

Public sector: An umbrella term incorporating government (at national, regional and local levels), inter-governmental agencies and public service organizations.

Scaling up: This refers to the expansion of an intervention from a baseline level of implementation. In practical terms, scaling up an intervention may refer to increasing the number of districts that are conducting a certain project or the number of facilities providing a certain service or the reach of targeted beneficiaries such as young children with a specific service or product.

School feeding programs: A form of supplementary feeding that encourages children's school enrolment and improves their ability to pay attention in class. These programs vary and may include the provision of breakfast, lunch, a midmorning snack, or a combination of these. Sometimes, school feeding programs are integrated with health and nutrition education, parasite treatment, health screening, and provision of water and sanitation.

Sector: Comprised of all institutions, agencies, individuals and resources that are targeted towards a specific goal or issue (e.g. health)

Severe Acute Malnutrition (SAM): Weight-for-height more than 3 standard deviations below the mean of sex-specific reference data (severe wasting).

Small for Gestation Age (SGA): Birth weight below a given low %ile cut-off (typically the 10th %ile) for gestational age. SGA and IUGR are not synonymous; some SGA infants (e.g., those born to short mothers) may represent merely the lower extreme of the "normal" foetal growth distribution, while other normal weight infants may actually have been exposed to one or more growth-inhibiting factors. In individual cases, it is usually difficult to ascertain whether the observed birth weight is the result of restricted in utero growth.

Smallholder farmer: Marginal and sub-marginal farm households that own and/or cultivate typically less than two hectares of land. Smallholder farmer households constitute a large

proportion of the population in the developing world and of households living in poverty and hunger.

Social development: Measures for poor, excluded and vulnerable women and men to have equal access to opportunities and to contribute to social and economic progress and share in its reward.

Social protection: The set of public interventions aimed at supporting the poorer and more vulnerable members of society, as well as helping individuals, families, and communities manage risk. Social protection includes safety nets (social assistance), social insurance, labor market policies, social funds, and social services.

Social safety nets: Non-contributory transfer programs targeted in some manner to the poor and those vulnerable to poverty and shocks—analogous to the U.S. term “welfare” and the European term “social assistance.”

Stakeholder: Used in the business sector to refer to all those who are linked to it, including shareholders, employees, customers, suppliers and communities in which the business operates. Increasingly adapted by partnership initiatives to mean all who are involved with or affected by a given activity.

Stunting (chronic malnutrition): Low height-for-age, defined as more than 2 SD below the mean of the sex-specific reference data. Stunting is the cumulative effect of long-term deficits in food intake, poor caring practices, and/or illness.

Supplementary feeding programs: A direct transfer of food to target households or individuals, most commonly maternal and young child feeding and school feeding. The food may be prepared and eaten on-site or given as a dry ration to take home. Supplementary feeding is often provided as an incentive for participation in public services such as primary health care and education.

Unconditional Cash Transfer (UCT): A social safety net program aimed at reducing both present and future poverty through a transfer of cash to vulnerable and specifically targeted populations.

Undernourished: A person whose usual food consumption, expressed in terms of dietary energy (kcal), is below the energy requirement norm. The prevalence of undernourishment in a specified population is sometimes used as a measure of food deprivation. This term is not to be confused with undernutrition.

Undernutrition: Poor nutritional status due to nutritional deficiencies. The main three indicators of undernutrition are stunting, wasting, and underweight.

Vitamin A: An essential micronutrient that plays an essential role in vision and immune response.

Wasting (acute malnutrition): low weight-for-height defined as more than 2 SD below the mean of the sex-specific reference data. Wasting is the result of a recent shock such as lack of calories and nutrients and/or illness, and is linked strongly to mortality.

Zinc: An essential micronutrient that plays a critical role in the structure of cell membranes and in the function of immune cells.

Zinc supplementation: reduces the duration and intensity of diarrheal illness and reduces clinical disease caused by acute respiratory infections and malaria.

Annex 2: Population-based surveys used for the descriptive analysis

The 2011 Comprehensive Food Security Survey (CFSS)

The 2011 Comprehensive Food Security Survey (CFSS) was chosen because it is a multi-dimensional study that includes information on demography, education, water and sanitation, household assets, agriculture and livestock, income and livelihoods, expenditures and debt, food consumptions, sources of food, coping mechanisms, household exposure to shocks, nutrition, infant and young child feeding practices, access to markets, health facilities and schools, market availability, market prices, impact of shock to markets and recovery.

The main source of information for the CFSS analysis was from primary data collected through three questionnaires: a household questionnaire, a questionnaire for women of reproductive age (15-49 years) living in the household and a questionnaire for children under five years of age, which included also the collection of anthropometric measurements. Focus group discussions were conducted in all the visited communities and trader surveys were implemented in important markets across the country.

Data were collected during November and December 2011 – the same months as the previous CFSS in 2009. Nineteen of the 21 governorates in Yemen were visited. Two governorates, Sa'ada and Al Jawf, were not accessible because of security issues.

Twenty teams, each with four enumerators and a supervisor, visited 570 communities across Yemen. In total 7,750 households were interviewed. More than 10,000 women were interviewed and more than 11,000 children were measured for weight, height and MUAC. In addition, over 170 markets were visited.

Data were entered on a daily basis into an Access database and then exported to SPSS for analysis. ENA and WHO Anthro software were used for the nutrition analysis. The work was supervised by staff from the Ministry of Health and Planning (MoHP), World Food Program (WFP) and United Nations Children Fund (UNICEF).

The CFSS sampling methodology

The Central Statistics Office (CSO) of Yemen gave the sampling frame, which was designed to provide representative statistics at governorate, agro-ecological zone, urban/rural and national levels.

The strata of investigation are the 21 governorates (two of which were not reachable), six agro-ecological zones and urban / rural areas. The six agro-ecological zones consist of the Arabian Sea coast, the Internal Plateau, the Red Sea and Tahama Coast and the highlands which are further divided into the two areas: above and below 1,900 meters.

A two-stage stratified cluster sample design was applied in the CFSS. The first stage of the two-stage cluster design was the selection of Enumeration Areas (EAs) in each governorate using

PPS (Probability Proportional to Size). The second stage was the random selection of households within each selected EA. The EAs were selected from a list of areas provided by the CSO of Yemen, which is based on the 2004 General Population Housing and Establishment Census and has established rates for updated estimates.

The required minimum sample size for each governorate was determined by using this formula:

$$n = z^2 \times \frac{p(1-p)}{d^2} \times k$$

Where:

n = Required minimum sample size

z = Z-Score corresponding to the degree of confidence

p = Estimate prevalence of the outcome being measured (food insecurity and/or malnutrition)

k = Design effect (required for two-stage cluster sampling)

d = Minimum desired precision or maximum tolerable error

The degree of confidence was set at 95 % (z=1.96). The estimate prevalence was set at 50 % assuming that it will yield the largest required sample size which is desired for analysis of multiple indicators of varying prevalence (p). The design effect (k) was set at 2 to adequately address effects of intra-cluster correlation as shown from previous food security studies. The minimum desired precision (d) was set at 8 % based on previous studies and budgetary constraints on sample size

Because of the lack of an updated census with accurate population figures, along with previous experience in sampling issues in Yemen, the CSO requested that the sample size for each stratum increases from 300 to 360 households. Based on the 19 strata, the minimum required overall sample size was 6,840 (360*19) households. In each stratum, a total of 30 Enumeration Areas were selected with a number of households to be interviewed ranging from a minimum of 12 to a maximum of 15.

Household weights and Individual weights for children and women were calculated based on the most recent population estimates provided by the CSO.

The 2013 UNICEF Knowledge, Attitude and Practices (KAP) baseline survey

This UNICEF KAP baseline survey was chosen because of its comprehensive overview of knowledge, attitude and practices that are relevant to child development, health and nutritional outcomes. The UNICEF KAP baseline survey only targeted vulnerable districts in Yemen with a total of 106 out of 333 districts. Results are therefore not representative of the national population. The survey provides information on demographics, education (adult population, child, and school facilities), fertility and maternal health, child nutrition and health status, infant and young child feeding practices, child protection including child labour, early

marriage, polygamy, water supply, sanitation and hand washing. Focus group discussions were conducted in all the visited communities

Three questionnaires were used in the UNICEF Baseline Survey: a household questionnaire, a questionnaire for women of reproductive age (15-49 years) living in the household and a questionnaire for children under five years of age, which included also the collection of anthropometric measurements (height, weight and middle upper arm circumference). The child questionnaire included a module on breast-feeding and complementary feeding practices for children 6-23 months.

The final sample comprised 305 Enumeration Areas, with a final valid sample of 3,544 households, 5,453 women and 3,801 children. The household level response rate was 93 %. Within households, women's and children's response rate was around 99 %. Observations were weighted for final analysis.

Daily quality checks were carried out on the anthropometric measurements of under five year olds using ENA for SMART 2011¹³. All scores¹⁴ were found to be either good or excellent.

Household weights and individual weights were applied in order to scale up the selected sample to the size of the targeted population and correct for unequal selection probabilities between strata and between Enumeration Areas. Weights were then adjusted by non-response factors.

The data was set using the -svyset- command in Stata12 and analysed using survey specific (-svy-) commands in the same software. Significance tests were carried out using Chi Square tests to assess significance of differences in categorical variables and adjusted Wald tests to assess significance of differences in mean. ENA and WHO Anthro software were used for the nutrition analysis.

UNICEF worked with the Yemeni Central Statistics Organisation (CSO) as implementing partner. Fieldwork was carried out in from late December 2012 until mid-March 2013.

The UNICEF KAP sampling methodology

The standard sample size calculation formula used by the Multiple Indicator Cluster Survey (UNICEF, 2012a) was applied for the UNICEF KAP Baseline survey.

The sample size was determined by using this formula:

$$N = \frac{(1-p)}{p \times RSE^2} \times \frac{DEFT}{r \times s \times (HH \text{ size})}$$

¹³ ENA for SMART is a free software used in quality assurance for SMART surveys. ENA stands for Emergency Nutrition Assessment. SMART stands for Standardized Monitoring and Assessment of Relief and Transitions.

¹⁴ Scores are the sum of various quality indicators, such as digit preference, age or sex distribution score.

<i>p</i>	Estimated prevalence rate of the targeted estimator	0.2
<i>RSE</i>	Relative standard error associated with a 95% confidence level	0.1
<i>DEFT</i>	Estimated design effect	1.5
<i>r</i>	Estimated household response rate	0.93
<i>s</i>	Estimated share of the target group in population (U5 children)	0.13
<i>HH size</i>	Estimated average household size	7.54
<i>N</i>	Sample size per strata	656

For the UNICEF KAP Baseline survey, a relative standard error of 10% and a confidence level of 95 % were adopted. The sample size calculations were based on an assumed prevalence rate of Global Acute Malnutrition (by weight and height) of 20 % based on the results from Standardized Monitoring and Assessment for Relief and Transition (SMART) surveys conducted in five governorates during 2012¹⁵. The household response rate, the household size and the share of children under five years were all estimated based on the unweighted, preliminary data from the Social Protection Monitoring (SPM) survey. The household size was set at 7.54 and the share of children under the age of 5 at 13 %. SPM response rates varied across governorate, with the lowest rates in Sana'a at 93 %. The design effect was set at 1.5 which is common for stratified cluster sampling. Using these data gave a sample size of 656 households per strata. The UNICEF survey report provides an appendix for precision levels related to different prevalence rates.

To obtain precise estimates for indicators at the regional level, the 106 selected districts were grouped into five strata. Based on the five strata, the minimum required overall sample size was 3,289 households (656*5). A lump sum of 536 households was added to counterbalance the fact that the strata were not all of equal size and in order to achieve a more equal sampling interval¹⁶ and hence lower variance in weights¹⁷.

The allocation of households to strata was carried out by using the linear programming add-on SOLVER in Microsoft Excel with two conditions in mind:

1. The sample population in each strata had to be at least 656 households so as to obtain estimates with a desired level of precision
2. The variance of the sampling interval across strata had to be minimized. A variance of zero would be achieved by applying a sampling proportionate to the population size.

A two-stage stratified cluster sample design was applied in the UNICEF KAP Baseline Survey. The first stage of the two-stage cluster design was the selection of Enumeration Areas (EAs) in

¹⁵ Recent SMART surveys for the governorates of Aden, Hajja, Hodeida, Lahj, Rayma and Taiz (UNICEF, 2012b, 2011, 2012c, 2012d, 2012e, 2012f) show that unweighted Global Acute Malnutrition rates across governorates are around 17 % (this average is merely to inform sample size calculations and not for reporting purposes).

¹⁶ The sampling interval refers to the ratio of sample size to total underlying population.

¹⁷ Originally this lump sum was set at 520, translation of this number to full clusters of twelve households it increased to 536.

each governorate using PPS (Probability Proportional to Size). The second stage was the random selection of households within each selected Enumeration Area. The Enumeration Areas were selected from a list of areas provided by the Central Statistical Office of Yemen, which is based on the 2004 Population General Population Housing and Establishment Census and has established rates for updated estimates.

Though a counting of households revealed that, on average, the population grew by about 22 households in each Enumeration Area between 2004 and 2013, it grew by on average 44 households per Enumeration Area in the Tihama, while it shrank by 10 households in the Northern Lowlands¹⁸. Since the sampling process was carried out independently within strata, this may bias the sample within strata not across strata.

In total, 318 Enumeration Area were selected. This number was obtained by dividing the entire sample of 3,816 households by the cluster size of 12 households. The population in the selected Enumeration Area was relisted¹⁹ except when there were overlaps with the relisting conducted for the concurrent 2013 Social Protection Monitoring (SPM) Study and the 2013 Yemen National Demographic Health Survey (YNDHS). This was the case for 28 Enumeration Area. The variation of households in each Enumeration Area was significant, from 323 households in the largest ones to 29 households in the smallest ones. In order to facilitate data collection in large Enumeration Areas and to obtain Enumeration Areas of comparable size, Enumeration Areas containing more than 131 households were split into equal parts. A dummy sampling stage was inserted to select one from among the split Enumeration Area. Once the enumeration area had been relisted and split, households were selected using the Stata command – sample – to randomly select households from each Enumeration Area.

A total of 11 Enumeration Area, or 3 % of the total, could not be accessed for data collection. The final sample comprised 305 Enumeration Area, with a valid sample of 3,544 households. This amounts to an estimated population size of 1,080,817 households, excluding Sa'ada.

Reported limitations of the UNICEF KAP baseline survey:

The first limitation was that the generated wealth quintiles proved to not correlate well or predict important indicators and were therefore omitted from the analysis. A possible explanation for this was that the asset composition of the underlying population in the 106 UNICEF target districts did not vary enough. In other words, the underlying population was too homogeneously poor to be able to observe significant wealth differences merely on the basis of assets. The second limitation was that, despite the fact that the underlying sample was made up of rural people, elements linked to agriculture such as land ownership and livestock ownership had very low loadings. Possible explanations for this were that either respondents

¹⁸ With respect to the Northern Lowlands, conversations with government officials suggest that during the 2004 census the number of households in certain enumeration areas was over-estimated. Government staff suggested that in areas where in fact no one lives, hundreds of households were listed.

¹⁹ Relisting refers to the process of counting each household in selected enumeration areas.

misrepresented land and livestock ownership, or, that rural people do largely not own land and livestock anymore but live from wage labour, similar to their urban counterparts (Mundy, al-Hakimi, & Pelat, 2013).

The 2013 Yemen National and Health Demographic Survey (YNHDS)

The 2013 Yemen National Health Demographic Survey (YNDHS) was conducted by the Central Statistical Office (CSO) and the Ministry of Health and Population of Yemen along with ICF International (previous Macro International) and funded mostly by USAID with support from other bilateral and multilateral donors. The primary objective of the YNHDS is to provide up-to-date estimates of basic demographic and health indicators that include information on: marriage, fertility and fertility preference, knowledge and use of family planning methods, infant and young child feeding practices, nutritional status of women and children, maternal and childhood mortality, awareness and attitudes regarding HIV/AIDS, female genital cutting, and domestic violence. This information is intended to assist policymakers and program managers in evaluating and designing programs and strategies for improving health and family planning services in the country.

The results of the 2013 YNHDS are based on 781 clusters that were actually visited during the data collection phase. Out of the 800 clusters initially selected, ten were not listed and, at the time of data collection, nine additional clusters were not visited for security reasons.

A total of 19,517 households were selected for inclusion in the YNHDS, and of these, 18,027 were found to be occupied. Of the 18,027 occupied households, 17,351 were successfully interviewed, yielding a response rate of 96 % (97 % in rural areas compared with 95 in urban areas). In the interviewed households, a total of 17,318 ever-married women were identified to be eligible for the individual interview, and 96 % of them were successfully interviewed. For never-married women, 9,488 were identified as eligible for interview, and 93 % of them were successfully interviewed.

The sample for the 2013 YNHDS was designed to provide population and health indicator estimates at the national and governorate levels. The smallest Governorates in terms of population were oversampled while the largest were under-sampled. The 2004 General Population Housing and Establishment Census was used as the sampling frame. The 2013 YNHDS sample was selected using a stratified two-stage cluster design consisting of 800 clusters, with 213 in urban areas and 587 in rural areas.

A complete listing of households and a mapping exercise were carried out for each cluster from November 10 to November 31, 2012, with the resulting lists of households serving as the sampling frame for the selection of households in the second stage. All regular households were listed. In each rural cluster, one household was randomly selected. This household and the subsequent 24 households in the list together constituted the household sample for each of the 587 rural clusters; in urban clusters, the 25 households were randomly selected. The total of 800 clusters was estimated to yield a sample of 20,000 households at the national level.

All ever-married and never-married women aged 15-49 years in each selected household were eligible to be interviewed. In addition, in one-third of selected households, all women as well as children below 59 months were eligible for anthropometric measurements as well as to be tested for anemia (only children aged 6-59 months). The Mid-Upper Arm Circumference (MUAC) was also measured among all women aged 15-49 years. The cooking salt in the household was tested for iodine concentration.

Three questionnaires were used in the 2013 YNHDS: a household questionnaire, and two individual questionnaires (one for ever-married women and an abbreviated version for never-married women). Several modules were added to the original set of questions including one on food security.

All aspects of data collection were pre-tested from November 20 to December 12, 2012. Twenty-four participants (16 females and 8 males) attended the two-week training in the administration of the YNHDS survey instruments, anthropometric measurement and haemoglobin testing. A total of 124 household interviews (70 in urban and 54 in rural areas) were conducted in which 161 eligible women were located and interviewed. The four-week main training for 278 field staff took place from August 18 to September 12, 2013. The training included lectures, role playing, mock interviews, field practices on the use of the questionnaire, height and weight measurements and biomarker collection. In total all teams completed 228 household questionnaires, 228 ever-married woman questionnaires, 173 single woman questionnaires, 445 height and weight measurements and 400 haemoglobin tests.

Fieldwork was launched simultaneously in all governorates immediately upon the conclusion of field staff training. Forty interviewing teams carried out data collection for the 2013 YNHDS. Data collection took place over a three-month period, from September 14 through November 23, 2013 with a two-week interruption (October 10-25).

The processing of the YNHDS data with the Census and Survey Processing System (CSPro) began as soon as questionnaires were received from the field. Completed questionnaires were returned from the field to the headquarters, where they were entered and edited by data processing personnel who were specially trained for this task, and had also attended questionnaire training of field staff. Data were supposed to be processed concurrently with data collection to allow for regular monitoring of team performance and data quality. However, data entry was slow during the first few weeks and the “field check” tables that were supposed to be regularly generated to check various data quality parameters were not produced early enough to provide feedback to the data collection teams during the first weeks of fieldwork. Coding was completed on January 15, 2014 and data entry, which included 100 % double entry to minimize keying error and data editing, was completed on February 15, 2014. Data cleaning was completed on March 3, 2014. Secondary editing, imputation, and calculation of survey weights were completed by mid-April, 2014.

The YNHDS report is still preliminary and is not complete. However, the endorsed findings on female reproductive health and maternal health have been used for the descriptive analysis of this research to compensate for the lack of information in the other two surveys.

Annex 3: Variables included in the quantitative analysis

Table 22 (Annex 3): Variables included in the quantitative analysis for the country of Yemen based on the 2011 Comprehensive Food Security Survey dataset

N	Short name of the variable	Definition of the variable	Type of variable
1	Child stunting	HAZ<-2SD – Height for age (measure of linear growth). Indices are expressed as standard deviation unit from the median of the WHO Child Growth Standards adopted in 2006. Children, who fall below minus two standard deviations (-2 SD) are regarded as moderately stunted.	Outcome dependent (<i>main</i>)
2	Child severe stunting	HAZ<-3SD – Height for age. Children, who fall below minus three standard deviations (-3 SD) are regarded as moderately stunted.	Outcome dependent (<i>main</i>)
3	Child wasting	WHZ<-2SD – Weight for height (describes current nutritional status). Children, who fall below minus two standard deviations (-2 SD) are regarded as moderately wasted.	Outcome dependent (<i>secondary</i>)
4	Child severe wasting	WHZ<-3SD. Children, who fall below minus three standard deviations (-2 SD) are regarded as moderately wasted.	Outcome dependent (<i>secondary</i>)
5	Child diet diversity	Number of food groups a child between 6-23 months consumed in the last 24 hours. Access to 4+ food groups is considered the minimum amount for child diversity (WHO recommendation).	Immediate determinant
6	Child diarrhoea incidence	Child had diarrhoea in the previous two weeks.	Immediate determinant
7	Maternal nutrition status (MUAC)	Proxy for mother malnourished status based on the Mid-Upper Arm Circumference (MUAC) cut-off point of ≤ 23 cm (Sphere standards). The Yemen surveys have used ≤ 22.2 cm for moderate malnutrition and ≤ 21.3 for severe malnutrition.	Risk factor
8	Birth spacing	Number of children below 5 years of age per mother used as a proxy for birth spacing	Risk factor
9	Child access to animal-based food sources	Number of animal-protein food groups a child between 6-23 months consumed in the last 24 hours. Animal-protein food groups include: dairy products, meat and fish and eggs	Household practice
10	Child Vitamin A supplementation	Child received one Vitamin A supplement in the last six months	Public intervention
11	Household access to sanitation facility	Household accesses an improved sanitation facility defined as: flush toilet/sewer system/septic tank; flush/pour system to latrine; improved pit latrine; pit latrine with slab.	Public intervention

N	Short name of the variable	Definition of the variable	Type of variable
12	Household access to drinking water facility	Household accesses an improved drinking water facility defined as: piped water into premises; public tap or standpipe; protected well; protected spring; rain water collection	Public intervention
13	Child age	Child age in months category: 12-17 months (compared to 6-11 months) Child age in months category: 18-23 months (compared to 6-11 months)	Child characteristic
14	Child gender	Child female (compared to male)	Child characteristic
15	Maternal education	Spouse illiterate ²⁰ used as a proxy for maternal education	Maternal characteristic
16	Female household head	Gender of the household head is female	Household head characteristic
17	Household head age	Age of the household head at the time of the survey	Household head characteristic
18	Household head education	Household head illiterate	Household head characteristic
19	Household Size	Number of household members	Household characteristic
20	Household wealth index	Only used in the basic model specification (when assets are not included in the model) Household Wealth Index involves the Principal Component Analysis (PCA) of variables relating to ownership of assets and housing conditions. It is used to divide households into quintile that can be more easily described.	Household characteristic
21	Household expenditure per capita	Log expenditure per capita	Household characteristic
22	Household expenditure on Qat ²¹	Share of expenditure to purchase Qat	Household characteristic
23	Household access to land	Dummy 1 if household has access to land	Household characteristic
24	Household share of workers abroad	Share of household members that are working abroad	Household characteristic
25	Household owns a cooking stove	Household owns an efficient cooking source (LPG or kerosene).	Household characteristic
26	Household owns a fridge	Household owns a fridge	Household characteristic
27	Household affected by	Three main shocks affecting the households in the	Household

²⁰ The 2011 CFSS did not collect information on the mother's education

²¹ Qat is a narcotic plant largely produced and consumed in Yemen

N	Short name of the variable	Definition of the variable	Type of variable
	a shock	previous six months: high health expenditures; high food prices, lack/late rain, insecurity/violence, high debt to repay, reduced remittances/wages and loss of employment.	characteristic
28	Household residence	Dummy 1 for rural residence	Household characteristic
29	Household agro-ecological location	Agro-ecological areas defined as Red Sea and Tihama Coast, Arabian Sea, Internal Plateau, Desert, Dry Highland compared to Temperate Highlands	Household characteristic
30	Household livelihoods (main income sources)	Relative contribution of (up to) the four most important income generating activities in which the household was engaged in the preceding year including: agriculture, livestock, fishery, qat, petty trade, collection of wood, private business, wage (non-government) and driver, government salary, pension, remittances and Social Welfare Fund.	Household characteristic

Source: author

Annex 4: Summary of key results presented to decision-makers

Table 23 (Annex 4): Summary of key results from the descriptive and quantitative analysis presented to decision-makers, Yemen 2014

Factor of interest	Results from the descriptive analysis	Results from the quantitative analysis
Child characteristics		
Child age	<ul style="list-style-type: none"> Stunting prevalence steadily increases in the age group between 6-23 months and then flattens between 24-59 months (2013 YNDHS and 2011 CFSS). Wasting prevalence is higher in infants below 18 months with a peak between 6-8 months coinciding with the introduction of complementary foods (2013 YNDHS and 2011 CFSS). High incidence of wasting among infants less than six months (20 % moderately and 9 % severely wasted; 2013 YNDHS). 	<ul style="list-style-type: none"> The probability of being stunted increases with age as shown when comparing age group 12-17 and 18-23 with age group 6-11 (2011 CFSS). The probability of being wasted reduces with age as shown when comparing age group 12-17 and 18-23 with age group 6-11. The age is not statistically significant for severe wasting (2011 CFSS). The probability of consuming more food groups (diet diversity) increases with age as shown when comparing age group 12-17 and 18-23 with age group 6-11 (2011 CFSS).
Child gender	<ul style="list-style-type: none"> Stunting prevalence is highest among boys than girls (48 versus 45 %; 2013 YNHDS). Not noticeable in the 2011 CFSS (47 versus 46 %). Wasting prevalence is higher among boys than girls (18 versus 15 %; 2013 YNDHS). Noticeable in the 2011 CFSS (15 versus 11 %). 	<ul style="list-style-type: none"> Being a girl reduces the probability of being stunted or (to a less extent) being wasted (2011 CFSS). Being a girl does not show statistically significant associations with child diet diversity (2011 CFSS).
Child place of residence	<ul style="list-style-type: none"> Significant difference in stunting prevalence between rural and urban children (51 versus 34 %; 2013 YNDHS). Similar difference in the 2011 CFSS (51 versus 36 %). Slight difference in wasting prevalence between rural and urban children (17 versus 14 %; 2013 YNDHS). No difference noted in the 2011 CFSS. 	<ul style="list-style-type: none"> Residing in rural areas or in different agro-ecological areas do not show statistically significant associations with child stunting or child wasting (2011 CFSS). Residing in rural areas do not shows statistical association with child diet diversity (2011 CFSS). When using one base category (Temperate Highland) only the Coastal area perform better in relation to the child diet diversity while the Dry Highlands perform worse (2011 CFSS).

Factor of interest	Results from the descriptive analysis	Results from the quantitative analysis
Birth outcome and related factors		
Low-birth weight (<2,500 grams)	<ul style="list-style-type: none"> 32 % of infants estimated to be born with a weight below 2500 grams (WHO estimates for the period 2000-2008). 	<ul style="list-style-type: none"> No data available in the 2011 CFSS datasets to perform the regression. Low-birth weight is statistically associated with an increased probability of a child being stunted child being stunted (2013 UNICEF Baseline).
Nutrition status of women of reproductive age (15-49 years)	<ul style="list-style-type: none"> 24.2 % of women are malnourished (MUAC <22.2) with 39 % in the age group 15-19 years (2011 CFSS). 14.4 % of women are severely malnourished (MUAC <21.3 cm) with 25.2 % in the age group 15-19 years (2011 CFSS). 51 % of women are over-weight and 23 % are obese (WHO estimates for the period 2000-2008). The %age among women aged 15-19 years is 12 and 4 respectively. 	<ul style="list-style-type: none"> The mothers' low MUAC is a statistically significant predictor of a child being stunted, severely stunted and wasted (2011 CFSS).
Total Fertility Rate	<ul style="list-style-type: none"> 4.4 children was the average fertility rate in 2011-13 with a significant difference between rural and urban women (5.1 versus 3.2 respectively). It declined from 6.5 births in 1995-97 with the biggest change in the past ten years (2013 YNDHS). 	<ul style="list-style-type: none"> The number of children under five years within the same household significantly predicts the probability of a child being stunted or severely stunted or severely wasted (2011 CFSS).
Birth by age 15 and birth by age 18	<ul style="list-style-type: none"> Early child bearing is declining. For birth before age 15, women between 15-19 years at the time of the survey were about six time less likely to have had a birth compared with women in their forties or 2 % compared with an average of 12 % (2013 UNICEF). For birth before age 18, the chance was one in five among women in the early twenties (21 %) compared with one in three (33 %) among those in their forties (2013 UNICEF). 	<ul style="list-style-type: none"> Not modelled due to sample too small (2011 CFSS).
Access to family planning	<ul style="list-style-type: none"> 34 % of currently married women use a family planning method. The prevalence increased from 21 % in 1997 but still with significant differences between rural and urban areas (24 % 	<ul style="list-style-type: none"> No data available in the 2011 CFSS datasets to perform the regression.

Factor of interest	Results from the descriptive analysis	Results from the quantitative analysis
	<p>versus 40 %; 2013 YNDHS).</p> <ul style="list-style-type: none"> 29 % of currently married women use modern contraception with an increase from 10 % in 1997 (2013 YNDHS). 29 % of currently married women have an unmet need for family planning. 15 % for birth spacing with the highest demand among women below 30 years and 14 % for birth limiting with the highest demand among women aged 30 years or above (2013 YNDHS). 33 % of rural women and 33 % of women with no education have an unmet need for family planning compared with urban and educated women (20 and 15 % respectively; 2013 YNDHS). 	
Access to Ante-Natal Care	<ul style="list-style-type: none"> 60 % of women aged 15-49 years received at least one ANC visit for their last birth showing a significant almost doubling from 34 % in 1997. The prevalence is 51 % among rural women and 80 % among urban women. 93 % of women with the highest educational level went for ANC compared to 48 % of women with no education. (2013 YNHDS) 46 % of women aged 15-49 years received at least one ANC in the most vulnerable rural districts but only 25 % had four visits. The frequency does not differ by education level (2013 UNICEF). 	<ul style="list-style-type: none"> No data available in the 2011 CFSS datasets to perform the regression. The number of ANC visits is statistically associated with a reduced probability of a child being stunted (2013 UNICEF Baseline).
Access to birth delivery by health professional or in health facility	<ul style="list-style-type: none"> 45 % of births delivered by health professional, doubling from 22 % in 1997. The prevalence is 73 % among urban women and 34 % among rural women. The comparison by level of education is 89 % among women with highest education compared to 31 among women with no education (2013 YNDHS). 30 % of births delivered in health facilities, almost doubling from 16 % in 1997. The prevalence is 49 % among urban women compared with 23 % among rural women. The comparison by level of education is 65 % among women with highest education compared to 21 % with no education (2013 YNDHS). 	<ul style="list-style-type: none"> Birth delivery in health facility does not show a statistically significant association with child stunting (2013 UNICEF Baseline).
Complementary feeding among children between 6 and 23 months of age and related factors		
Complementary feeding among children between	<ul style="list-style-type: none"> 20 % of children (6-23 months) meet the recommended Minimum Dietary Diversity (≥ 4 groups consumed in the previous 24 hours) with a highest prevalence among children aged 18-23 months (2011 CFSS). 	<ul style="list-style-type: none"> Child dietary diversity (number of food groups) is significantly associated with lower probability of a child 6-23 months being stunted or severely stunted

Factor of interest	Results from the descriptive analysis	Results from the quantitative analysis
6 and 23 months of age	<ul style="list-style-type: none"> 15 % of children consumed Vitamin A rich foods, with no difference between the age groups (2011 CFSS). 33 % consumed animal-protein sources of foods with a higher prevalence in the age group 18-23 (42 %) compared with the age group 12-17 (31 %) and the age group 6-11 (27 %; 2011 CFSS). Minimum meal frequency and minimum diet diversity increases among the age group 18-23 compared with younger groups (2013 UNICEF) 20 % of mothers with education provide the recommended minimum dietary diversity compared to 13 % of mothers with no education (2013 UNICEF). All surveys report that there are no differences in the feeding practices between males and females and between urban and rural areas. 	<p>(2011 CFSS).</p> <ul style="list-style-type: none"> The same applies for the probability of a child being wasted and severely wasted (2011 CFSS). Two variables for child diet diversity (number of food groups and number of animal-protein sources of foods) were modelled as dependent variables (2011 CFSS).
Optimal breastfeeding for children up to two years of age	<ul style="list-style-type: none"> 10 % of infants under six months are exclusively breastfed. Milks and complementary foods are already introduced by 3 months (2013 YNHDS). Similar findings from the 2011 CFSS (11.6 %). 42 % are fed with a milk-bottle, a practice discouraged in unsanitary settings because of increased risk of diarrhoea (2013 YNDHS). 32 % of children 6-23 months are breastfed (2011 CFSS). 11 of mothers with education are exclusively breastfeeding their infants compared with 23 % of mothers with no education (2013 UNICEF). Financial constraint is seen by mothers as the main reason for continuing practicing exclusive breastfeeding for the first six months (2013 UNICEF). All surveys report that there are no differences in the breastfeeding practices between male and female infants and also between rural and urban areas. 	<ul style="list-style-type: none"> Sample too small to get any significant result from the regressions (2011 CFSS).
Promotion of IYCF practices for children up to two years of age	<ul style="list-style-type: none"> 15 % of mothers delivering in a health facility and 29 % of mothers delivering at home initiate breastfeeding within one hour as recommended (2013 UNICEF). 67 % of mothers delivering in health facility and 79 % of mothers delivering at home initiate breastfeeding within 24 hours (2013 UNICEF). The findings point to the poor quality of the facility-based IYCF services as reported also in the group discussions (2013 UNICEF). 	<ul style="list-style-type: none"> No intervention data on IYCF promotion to perform regressions (2011 CFSS).
Household food security	<ul style="list-style-type: none"> 45 % of the population found to be food insecure with 51 % among the rural population and 27 % among the urban population. 22 % are identified as severely food insecure, doubling from 12 % in 2009 (2011 CFSS). The main difference in the daily diet patterns over a one-week recall time is in the 	<ul style="list-style-type: none"> Not used in the regressions; the model used household wealth (2011 CFSS). The model used dietary diversity (number of food groups) consumed by the child 6-23 months (2011

Factor of interest	Results from the descriptive analysis	Results from the quantitative analysis
	consumption of vegetables, fruits, pulses and animal-protein sources. These food items are never or rarely consumed by severely food insecure people compared with food secure people that consume the same food items from 1 to 4 days a week (2011 CFSS).	CFSS).
Female head of household	<ul style="list-style-type: none"> 52 % of women-headed households are food insecure compared with 44 % among male-headed households. 	<ul style="list-style-type: none"> Being a female head of household increases the probability of a child being stunted compared with a male head of household (2011 CFSS). Consistent with findings from 2013 UNICEF
Household wealth	<ul style="list-style-type: none"> The household wealth index involves the analysis of variables relating to ownership of assets and housing conditions. It is used to divide households into quintiles. 32 % of the wealthiest households earn their income from agriculture production followed by Government salary, remittances and petty trade (28 % respectively). Households earning their income from agriculture production, pension or Government salary are those less likely to be in the lowest wealth quintile (2011 CFSS). 69 % of poorest households earn their money from agriculture wage followed by family or social welfare support (67 %), livestock (65 %) and fishing (62 %; 2011 CFSS). 	<ul style="list-style-type: none"> In the basic specification, the wealth of a household decreases the probability of a child being stunted or to a less extent severely stunted, wasted or severely wasted (2011 CFSS)
Household expenditures	<ul style="list-style-type: none"> 45 % of all household expenditures is dedicated to the purchase of food. The severely food insecure spend on staples 35 % compared with 20 % by food secure households, who spend more on expensive foods like meat, fruits and vegetables (2011 CFSS). High food prices are dependent on the volatility of prices for imported commodities like grains, oils and sugars and transport costs of perishable domestic products. 	<ul style="list-style-type: none"> The log expenditure does not show a statistically significant association with child stunting or child wasting (2011 CFSS). The log expenditure shows a significant and positive association with the number of food groups consumed by the child (2011 CFSS)
Household assets	<ul style="list-style-type: none"> Not analysed separately 	<ul style="list-style-type: none"> Owning agricultural land does not show a statistically significant association with child stunting or child wasting (2011 CFSS) Owning an improved cooking stove is associated with a decreased probability of a child being

Factor of interest	Results from the descriptive analysis	Results from the quantitative analysis
		<p>stunted, severely stunted or severely waste (2011 CFSS).</p> <ul style="list-style-type: none"> • Owning a fridge as well as owning a radio decrease the probability of a child being wasted (2011 CFSS). • Owning a fridge as well as owning an improved cooking stove increase the number of food groups consumed by a child (2011 CFSS).
Household exposure to shocks	<ul style="list-style-type: none"> • 90 % of households report high food prices as their main shock during the previous six months followed by high fuel prices (40 %) and high debt (20 %; 2011 CFSS). • Around 45 % of wage households (agriculture and not) and support-dependent households are affected by food debts (2011 CFSS). 	<ul style="list-style-type: none"> • Statistically significant shocks for the child diet diversity are those related to expenditures such as high food prices, high debt to repay and high health expenditures (2011 CFSS). • Loss or cut of remittances or wages reduce the number of food groups consumed by a child (2011 CFSS).
Household livelihoods	<ul style="list-style-type: none"> • Livelihoods that derive the main income from fishing or livestock have the lowest prevalence of food insecure households (21 % and 23 % of food insecure households respectively). However, they account among the lowest wealth quintiles in terms of assets and housing conditions with 41 % and 28 % of households classified as poorest (2011 CFSS). • Livelihoods that derive their main income from crop production, Government salary, petty 	<ul style="list-style-type: none"> • Agriculture/fishery/livestock are used as base category and significantly outperform all other livelihood groups (regular salary, wage labour/drivers, private business, wood/petty trade, remittances/pension/support, <i>qat</i>) in relation to

Factor of interest	Results from the descriptive analysis	Results from the quantitative analysis
	<p>trade, non-government salary, remittances and pension have around 40 % of food insecure households but also around 70 % of households classified as middle and wealthy (2011 CFSS)</p> <ul style="list-style-type: none"> • Livelihoods that derive their main income from agriculture wage or support (family or social welfare fund) are those with the highest prevalence of food insecure households (61 % and 68 % respectively) as well as with the highest prevalence of poor and poorest households (43 % and 46 % respectively; 2011 CFSS). • <i>Qat</i> production and consumptions is regarded as a widespread social issue in Yemen, involving both rural (both producers/consumers) and urban (both traders/consumers) population. 	<p>number of food groups and, particularly, number of animal-protein food groups consumed by a child (2011 CFSS).</p> <ul style="list-style-type: none"> • Agriculture/fishery/livestock shows the strongest positive association with the number of animal protein food groups consumed by a child. On the contrary, wage labour/drivers and remittances/pension/support show the strongest negative association with the number of animal food groups consumed by a child (2011 CFSS). • <i>Qat</i> as a source of income or as a share of expenditure does not show any statistically significant association with child diet diversity (neither with child stunting or child wasting; 2011 CFSS).
Diarrhoea incidence and exposure to environmental enteric dysfunction among children 6-23 months		
Diarrhoea incidence among children 6-23 months (and children under 5 years)	<ul style="list-style-type: none"> • 31 % of children had diarrhoea in the two weeks preceding the survey (2013 YNHDS). This is consistent with the 39 % reported by the 2013 UNICEF baseline. • 41 % of girls suffer from diarrhoea compared with 37 % of boy (2013 UNICEF). • 50 % of the children in age group 6-23 months suffer from diarrhoea (2013 UNICEF). • There is no difference by maternal education but a significant one by geographical location. 	<ul style="list-style-type: none"> • Diarrhoea incidence in the age group 6-23 months is significantly associated with wasting but not with stunting. Consistent with findings for the under-five age group (2011 CFSS). • Diarrhoea was not modelled as a dependent variable due to the data quality (two-weeks recall) and sample limitations (2011 CFSS).
Treatment of diarrhoea among children 6-23 months (and children under 5 years)	<ul style="list-style-type: none"> • 33 % of children with diarrhoea were taken to a health facility or a health provider with some difference observed for girls, rural children and children of mothers with no education. • 28 % received a rehydration solution (ORS) with no difference by gender, maternal education or residence (2013 YNDHS). This is consistent with the 26 % reported by the 2013 UNICEF baseline although there was a difference by maternal education. 	<ul style="list-style-type: none"> • No data available in the dataset to perform the regressions (2011 CFSS).
Vitamin A supplements for children 6-23	<ul style="list-style-type: none"> • 35 % of children received Vitamin A supplements in the six months previous to the survey with a slight difference by age group (34 % in the age group 6-23 months and 36 % in the age group 36 %). 	<ul style="list-style-type: none"> • Not statistically associated with a child being wasted or severely wasted or with the incidence of diarrhoea (2011 CFSS).

Factor of interest	Results from the descriptive analysis	Results from the quantitative analysis
months (and children under 5 years)		
Household hygiene practices	<ul style="list-style-type: none"> • 22 % of households still practice open defecation. This prevalence reduced from 44 % in 1990 (2014 JMP). • 39 % of the households practice open defecation in the most vulnerable rural districts with difference by agro-ecological zone ranging from 19 to 53 % (2013 UNICEF). • 43 % of households leave faeces of their young children in the open most commonly among households already practicing open defecation (65 %) but also among household with unimproved and improved sanitation facilities (35 and 26 % respectively). There is no significant difference by agro-ecological zone (2013 UNICEF). • 36 % of households found to not have a hand-washing place in their yard with a great difference by agro-ecological zone ranging from 21 to 68 %. 70 % of the hand-washing places had water and soap (2013 UNICEF). 	<ul style="list-style-type: none"> • Open defecation not statistically associated with stunting or wasting (2013 UNICEF Baseline) • Not modelled in the regressions because of sample too small (2011 CFSS)
Household access to safe drinking water sources	<ul style="list-style-type: none"> • 54 % of households have access to improved drinking water supply with piped water increasing to 40 % from 27 % in 1990 but also unimproved drinking water doubling from 28 to 41 % over the same period (2014 JMP). • 41 % of households have access to improved drinking water supply in the most vulnerable rural districts with 18 % accessing piped water and 12 covered wells. Still 27 % use unimproved drinking water sources with 16 % using surface water. There is a significant coverage difference by agro ecological zone ranging from 22 to 65 % (2013 UNICEF). • 27 % of households have access to drinking water in their own or neighbours household but 31 % spend more than one hour for the roundtrip to collect water. In 61 % of households, the burden falls on women in the age group 15-49 years (2013 UNICEF). 	<ul style="list-style-type: none"> • Access to improved water supply is strongly associated with a decreased probability of a child being stunted or severely stunted (2011 CFSS). • Treatment of water at point of use does not show a statistically significant association with stunting (2013 UNICEF).

Factor of interest	Results from the descriptive analysis	Results from the quantitative analysis
Household access to improved sanitation facilities	<ul style="list-style-type: none"> • 56 % of households have access to improved sanitation facilities with a doubling from 27 % in 1990 (2014 JMP) • 34 % of households have access to improved sanitation facilities in the most vulnerable rural districts with 28 % of the toilets flushing into a pit and 27 % using unimproved toilets flushing into the environment (2013 UNICEF). • 59 % of households whose head attended school were likely to have an improved sanitation facility compared with 41 %. There is a significant coverage difference by agro-ecological zone ranging from 21 to 51 % (2013 UNICEF). 	<ul style="list-style-type: none"> • Access to improved sanitation is associated with a decreased probability of a child being severely stunted or severely wasted and to a less extent stunted or wasted (2011 CFSS)
Girls' education		
Girls' education	<ul style="list-style-type: none"> • 61 % of rural girls are attending basic education compared to 86 % of urban girls • The highest drop in school attendance is when girls reach the onset of puberty around 12-13 years. The %age of female students drops from 92 % to 86 % in one year (2013 UNICEF) • Women, who attend schools are half as likely to get married by age 15 (11 versus 24 %) or by age 18 (27 versus 47 %). They are also less likely to have their first baby by age 18 (6 versus 11 %). 	<ul style="list-style-type: none"> • Literacy level of the spouse is a statistically significant predictor of the number of food groups consumed by a child but does not show any significant association with a child being stunted or wasted (2011 CFSS)
Early marriage	<ul style="list-style-type: none"> • Early marriage is declining at a similar rate of early child bearing. For marriage before age 15, women in the age group 15-19 at the time of the survey were around four time less like to be married compared with women in their forties. The comparison was 8 against an average of 30 % (2013 UNICEF). 	<ul style="list-style-type: none"> • No data to perform the regressions (2011 CFSS or 2013 UNICEF Baseline)